WYLE LABORATORIES PRODUCTS DIVISION

GERMANIUM LOGIC MODULES

INTRODUCTION

This catalog describes the standard line of Germanium logic modules manufactured by the Products Division of Wyle Laboratories. A complete selection of logical functions over a broad range of operating frequencies provides an economical answer to any system requirement.

These modules were selected from the more than 300 types of special and general purpose modules which Wyle Laboratories has designed and fabricated. The basic designs have been refined and revised to insure the optimum combination of reliability and simplicity. In addition, these modules are compatible with and, in most cases, interchangeable with Wyle modules in service in existing systems.

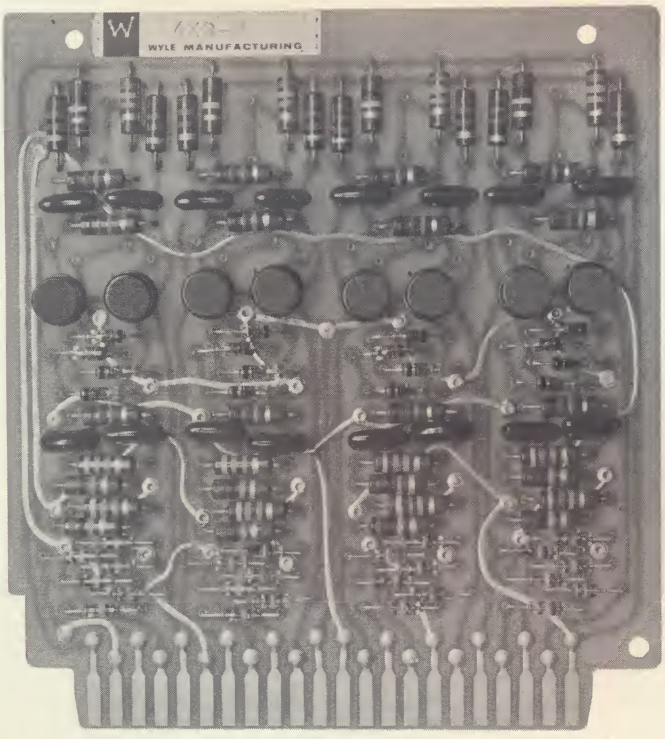
While this line of modules is comprehensive and flexible, there are occasions when specialized types are necessary. Available on special order are such types as

Model 2ST-M: Two AC amplifiers and two Schmitt Triggers
Model 2PA-M: Two photocell amplifiers
Model 2SS-M: Two fast recovery single-shots
Model EFC-M: Ten complimentary emitter followers

and a wide variety of specialized counters, gates, amplifiers, etc. For information about particular applications, contact Digital Products Manager — Wyle Laboratories, Product Division, or the Wyle sales representative in your area.

FEATURES

1. **Broadest selection of types**
2. **Wide range of frequencies**
3. **Keying prevents accidental reverse insertion.**
4. **One year warranty against all defects of material and workmanship.**
5. **Full compatibility over all frequency ranges.**
6. **Complete selection of mounting hardware and accessories.**



GENERAL SPECIFICATIONS

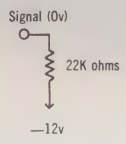
The following specifications apply to all Wyle standard Germanium logic circuit modules.

Physical Size:	
Width:	4½ inches
Length:	5 inches
Mounting:	9/16 inches, center-to-center
Logic Levels:	
Logical "One":	—10 ± 2 volts
Logical "Zero":	—0.25 ±0.25 volts
Operating Temperature Range:	0°C to + 50°C
Operating Frequency:	
D Series	DC to 1 kc
L Series	DC to 50 kc
M Series	DC to 200 kc
H Series	DC to 1 Mc
Rise Time Requirements:	
D and L Series	Not critical
M Series	0.5 μsec. max.
H Series	0.1 μsec. max.
Power Supply Tolerance:	±2% independent variation for +12 V and —12V
Input Duty Cycle:	50% ±10% at max. frequency

LOADING

The input load presented by each circuit module and the load which a module output will drive are expressed by a set of symbols based on the most commonly encountered loads.

A LOAD



One A Load

One A load is defined as the load presented by a 22 K ohm resistor connected to a voltage which is 12 volts more negative than the signal. This definition is based on the worst case, when the signal is at 0 volts.

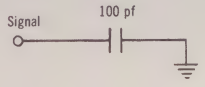
This type of loading is characteristic of AND gates.

N LOAD

One N load is defined as the load presented by a 33 K ohm resistor connected to a voltage 12 volts more positive than the signal. This definition is based on the case of the signal at —12 volts

One N Load

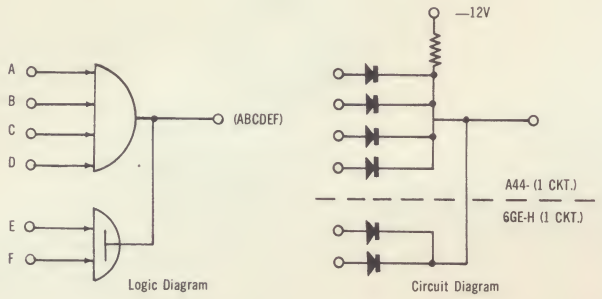
C LOAD



One C Load

One C load is the load represented by a 100 pf. capacitor to common or AC ground. When a circuit is loaded by the specified C load or less (including distributed wiring capacitance) the output will still retain the rise time required for the operation of other logic elements of the same frequency series.

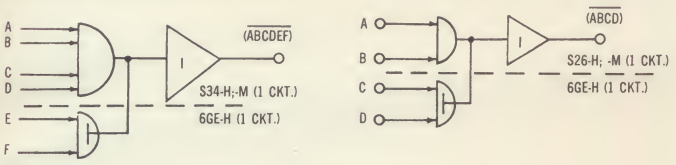
This is essentially a two term AND gate without the resistor. This circuit can be used to expand a four term AND gate to a six term gate as shown below:



The circuits on the 6GE-H module can also be used with external resistors to form conventional AND gates.

In either type of application, the number of input terms for any one gate should not exceed eight.

The 6GE-H can also be used to expand the input stage of NAND gates. Since a NAND is nothing more than an AND gate followed by an Inverting Amplifier, the 6GE-H can also be used to expand the input stage of a NAND gate. This requires that the point of connection which is both the AND gate output and the Inverter input (Node) be available. The node is available on the module connector for one circuit of the S26-M and S26-H, and for 3 of the 4 circuits on the S34-M and S34-H.



Logic Diagram: 6GE-H used to expand NAND gate

CURRENT DRAIN

The current which each module requires is listed for the +12 volt and the —12 volt supply. The values given are for the logically worst case; that combination of input and output signal values which requires the most current. These current values are not, however, for the worst case of component or power supply tolerances. The figures given represent an average or "nominal" worst case.

POWER SUPPLY TOLERANCES

To insure trouble free operation the two power supply voltages, +12 volts and —12 volts, should each vary no more than ±2%. This is the tolerance of Wyle's standard power regulators and if these power sources are used this limitation is of no concern. When using other power sources, however, this limit of ±2% independent variation should be observed.

SPURIOUS TRIGGERING

In systems applications, a possible source of logical errors is spurious triggering. Simple precautions in wiring techniques will prevent this type of error.

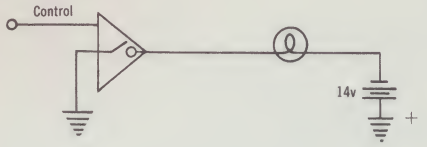
Large bundles of lead wires should be avoided since capacitive coupling between wires can introduce spurious signals onto adjacent leads. Particular care should be taken to separate incoming signals such as presetting or resetting signals, generated by relays or switches, from the lines carrying logic input or output signals to or from flip-flops.

One possible type of noise problem is triggering of flip-flops through noise introduced onto the output leads. If buffer amplifiers are used at the point where such signals leave the logic chassis, this problem can be eliminated.

POWER DRIVER MODULES

Wyle offers a variety of modules which include power drive capabilities. These range from specific power drivers to decoder matrices with power drive outputs. Rather than providing a specific voltage and current output, which would unduly restrict the types of output devices which the modules could accommodate, the Wyle modules operate as power switches to complete the circuit of load and power supply. By operating in this fashion, the circuits can be used over a wide range of voltage and currents.

As an example, consider an 8PA-D module with one of its eight circuits connected to drive a 14 volt lamp. The general circuit arrangement can be thought of as shown below.



The input to the power driver is through the control line. This is the input referred to by the specifications for "Input Loading" and "Input Voltage". When the input signal is at logical "one", the solid state switch closes completing the circuit through the load.

FLIP-FLOPS

4XD-M/4XD-H
BCD DECADE COUNTER

These modules are designed for general purpose decade counting applications in 8-4-2-1 BCD format. Each module is one complete decade and the modules can be connected in series to count several decades. The Model 4XD-M operates at input frequencies up to 200 kc; the Model 4XD-H at frequencies up to 1 Mc. The decade counter can be preset to any number by energizing the appropriate R-S preset inputs. The counters operate with all standard logic elements.

MODEL NO.:	4XD-M	4XD-H
Type:	Decade Counter (8421 BCD)	Decade Counter (8421 BCD)
Input Frequency:	200 kc	1 Mc
Input Amplitude:	−10 ±2 volts	−10 ±2 volts
Input Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Input Loading:	2.2 C	0.5 C
R-S Preset Levels		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts	−0.25 ±0.25 volts
R-S Loading:	2.75 N per input	4N per input
R-S Pulse Widths:	10 μsec. minimum[1] (per decade)	1.0 μsec. minimum[1] (per decade)
R-S Frequencies:	50 kc maximum	200 kc maximum
R-S Rise Time:	Not critical	Not critical
Collector Preset Pulse Width:	2.5 μsec. minimum[2]	0.25 μsec. minimum[2]
Output Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts	−0.1 ±0.1 volts
Output Loading:	10A + 7.5N + 5C	15A + 9N + 1.5C (1 Mc input freq.) 15A + 9N + 3C (200 kc input freq.)
Power: −12 volts	45 ma.	55 ma.
+12 volts	1.4 ma.	2.0 ma.

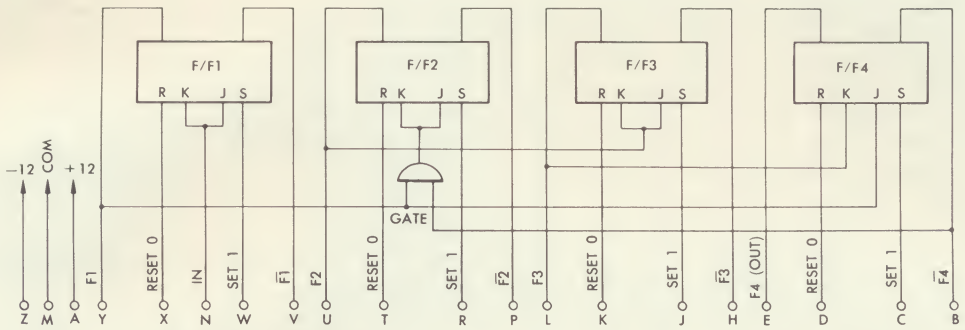
NOTES: 1 - This figure is accumulative when using more than one decade in series due to reset carry times. 2 - This figure is non-accumulative. Collector pre-setting by means of external diodes may be used on either the F or $\bar{F}$ outputs of each flip-flop.

4XG-M/4XG-H
4 GENERAL PURPOSE FLIP-FLOPS

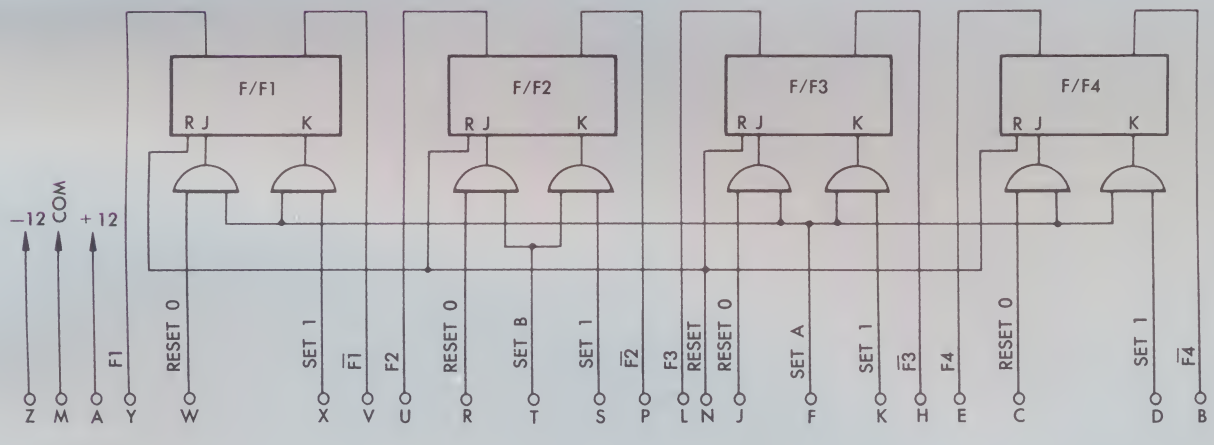
These modules provide four J-K type flip-flops for general purpose applications. The Model 4XG-M operates at frequencies up to 200 kc; the Model 4XG-H at frequencies up to 1 Mc. Typical applications for these modules include: counters (any scale up to 16), storage registers, serial entry shift registers, bi-directional counters, and ring counters.

MODEL NO.:	4XG-M	4XG-H
Type:	General Purpose Flip-Flops	General Purpose Flip-Flops
Reset 0, Set 1, Set B:		
Frequency:	200 kc maximum	1 Mc maximum
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Loading:	2.5A per input	4.75A per input
Set A:		
Frequency:	200 kc maximum	1 Mc maximum
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Loading:	7.5A	14.25A
Reset:		
Pulse Width	2.5 μsec. minimum[1]	0.25 μsec. minimum[1]
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Rise Time:	Not critical	Not critical
Loading:	11N	16N
Output:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts	−0.1 ±0.1 volts
Loading:	10A + 6N + 5C	15A + 9N + 1.5C (1 Mc) 15A + 9N + 3C (200 kc)
Collector Preset Pulse Width:	2.5 μsec. minimum[2]	0.25 μsec. minimum[2]
Power: −12 volts	55 ma.	86 ma.
+12 volts	1.2 ma.	1.6 ma.

NOTES:
1 - This figure is accumulative when using more than one card in series due to reset carry times.
2 - This figure is non-accumulative. Collector presetting by means of external diodes may be used on either the F or $\bar{F}$ outputs of each flip-flop.



4XD-M / 4XD-H BLOCK DIAGRAM



4XG-M / 4XG-H BLOCK DIAGRAM

FLIP-FLOPS

4XB-L

"R-S" FLIP-FLOP

The Model 4XB-L provides flip-flops for storage and general purpose logic at rates up to 50 kc. Minimum Set and Reset times are 2.5 microseconds. A common Reset line is provided for all four flip-flops. These units operate with all standard logic elements.

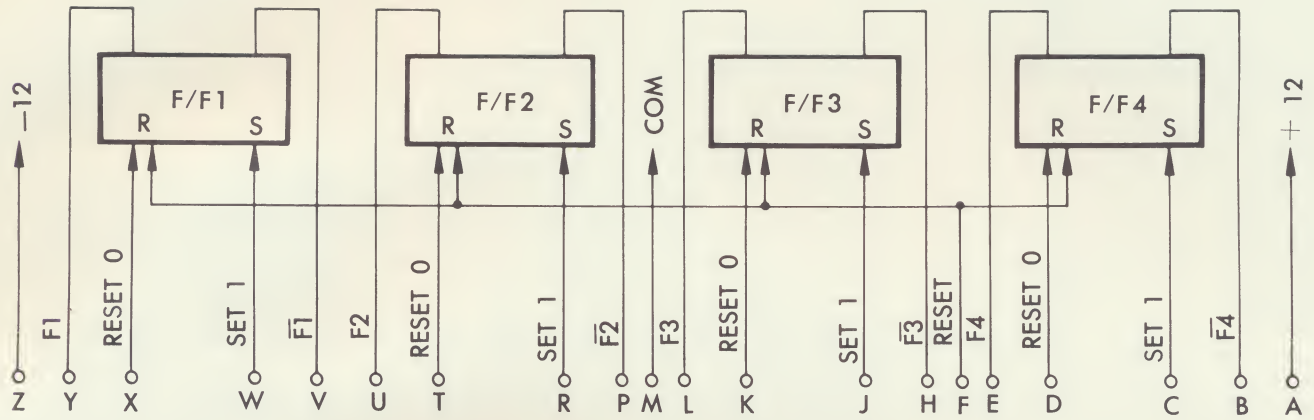
MODEL NO.:	4XB-L
Type:	4 R-S Flip-Flops
Input Frequency:	50 kc maximum
Input Rise Time:	Not critical
Input Loading:	2.75N per R-S Input
R-S Reset Levels:	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts
Reset Loading:	11N
R-S Reset Pulse Width:	2.5 μsec. minimum
Output Levels:	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts
Output Loading:	10A + 6N + 5C
Power: −12 volts	43 ma.
+12 volts	1.4 ma.

4XL-M / 4XL-H

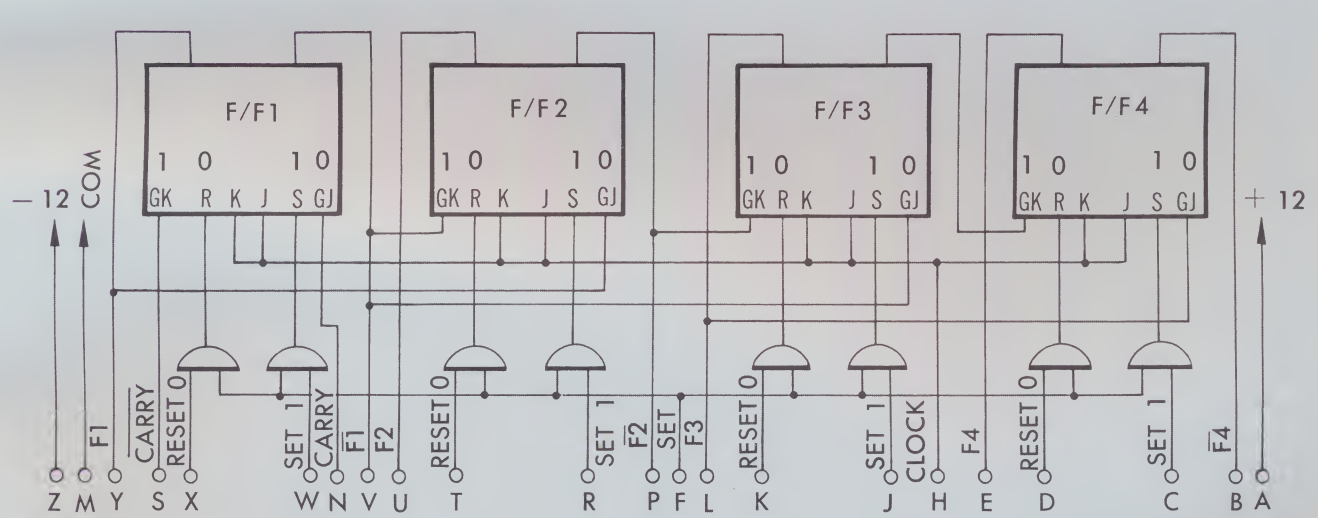
4 BIT SHIFT REGISTER

The Model 4XL-M provides a four bit shift register which may be operated at frequencies up to 1 Mc. The Model 4XL-H operates at clock frequencies up to 1 Mc. Each flip-flop is provided with a pair of DC gate inputs for Set 1 and Reset 0. A SET GATE input is provided which enables the parallel transfer into the Register of data at the inputs to the DC gates without requiring a reset interval. The unit is also provided with a single CLOCK input and with CARRY and $\overline{\text{CARRY}}$ inputs which may be used to implement shift registers having more than four bits.

MODEL NO.:	4XL-M	4XL-H
Type:	4 bit Shift Register	4 bit Shift Register
Clock Frequency:	200 kc maximum	1 Mc maximum
Clock Logic Levels:		
Logical "One"	−10 ±2 volts	−10 ±2 volts
Logical "Zero"	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Clock Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Clock Loading:	8.8C	2C
Carry, $\overline{\text{Carry}}$ Loading:	1A	1A
Set, Reset Frequency:	50 kc maximum	50 kc maximum
Set, Reset Pulse Width:	2.5 μsec. minimum	0.25 μsec. minimum
Set, Reset Loading:	5A	8A
Parallel Data Loading:	1.25A (per input)	2A (per input)
Output Levels:		
Logical "One"	−10 ±2 volts	−10 ±2 volts
Logical "Zero"	−0.1 ±0.1 volts	−0.1 ±0.1 volts
Output Loading:	10A + 6N + 5C	15A + 9N + 1.5C (at 1 Mc) 15A + 9N + 3C (at 200 kc)
Power: −12 volts	46 ma.	70 ma.
+12 volts	1.4 ma.	2 ma.



4XB-L BLOCK DIAGRAM



4XL-M/4XL-H BLOCK DIAGRAM

FLIP-FLOPS

4XH-M/4XH-H
4 BIT BINARY COUNTER

These modules provide a four bit binary counter. The Model 4XH-M operates at input frequencies up to 200 kc; the Model 4XH-H at input frequencies up to 1 Mc. These modules can be connected in series to form counters with more than four bits. Each module can be preset to any number from 0000 to 1111 by energizing the appropriate R-S inputs. The unit is designed to operate with all standard logic elements.

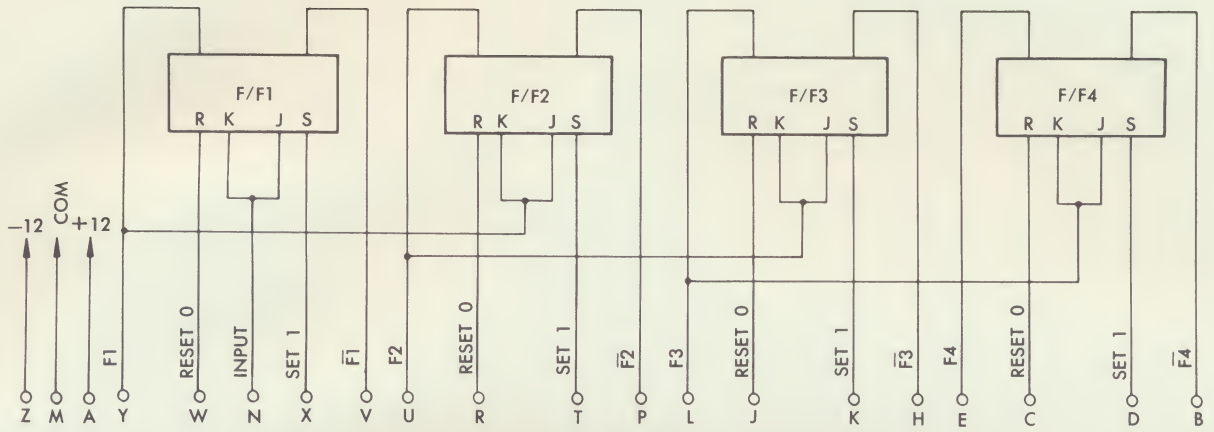
MODEL NO.:	4XH-M	4XH-H
Type:	4 Bit Binary Counter	4 Bit Binary Counter
Input Frequency:	200 kc	1 Mc
Input Amplitude:	10 ±2 volts	10 ±2 volts
Input Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Input Loading:	2.2 C	0.5 C
R-S Preset Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts	−0.25 ±0.25 volts
R-S Loading:	2.75N per input	4N per input
R-S Pulse Width:	10 μsec. minimum[1]	1.0 μsec. minimum[1]
R-S Frequencies:	50 kc maximum	200 kc maximum
R-S Rise Time:	Not critical	Not critical
Collector Preset Pulse Width:	2.5 μsec. minimum[2]	0.25 μsec. minimum[2]
Output Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts	−0.1 ±0.1 volts
Output Loading:	10A + 7.5N + 5C	15A + 9N + 1.5C (1 Mc input freq.) 15A + 9N + 3C (200 kc input freq.)
Power: −12 volts	45 ma.	55 ma.
+12 volts	1.4 ma.	2.0 ma.

NOTES: 1 - This figure is accumulative when using more than one card in series due to reset carry times.
2 - This figure is non-accumulative. Collector presetting by means of external diodes may be used on either the F or $\bar{F}$ outputs of each flip-flop.

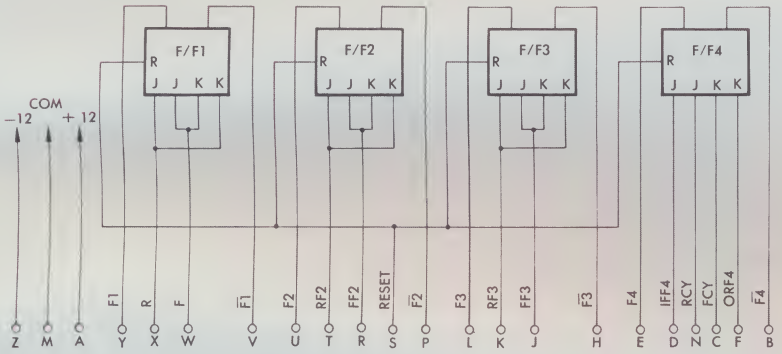
RDX-M/RDL-M
REVERSIBLE BCD DECADE COUNTER

The Type RDX-M/RDL-M Reversible BCD Decade Counter consists of two printed circuit cards; the first card contains four standard Wyle Laboratories flip-flops provided with dual inputs to permit counting in either direction. The second card contains the gating logic required to perform Up/Down counting in standard 1-2-4-8 binary coded decimal format. The flip-flops are provided with a common reset input to permit resetting of the counter. The logic card is provided with two inputs, "F" and "R" which cause the counter to count in the "Forward" (or additive) direction or in the "Reverse" (or subtractive) direction respectively. Provision in the driving logic must be included to insure that these inputs do not occur simultaneously. The counter is designed to operate at frequencies up to 200 kc.

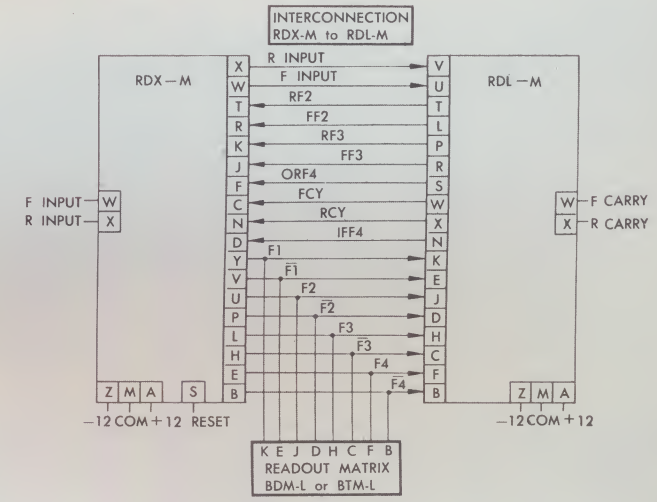
MODEL NO.:	RDX-M/RDL-M
Type:	Reversible Decade Counter
Input Frequency:	200 kc (F or R inputs)
Input Amplitude:	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts
Input Rise Time:	0.5 μsec. maximum
Input Loading:	
F Input:	10A + 8.8C
R Input:	10A + 8.8C
Reset Input Amplitude	
Logical "One" (Reset)	−10 ±2 volts
Logical "Zero" (Normal)	−0.25 ±0.25 volts
Reset Loading:	11N
Reset Pulse Width:	2.5 μsec. minimum
Output Loading:	
F1, $\bar{F1}$	2.5A + 7.5N + 1C
F2, $\bar{F2}$	7.5A + 7.5N + 1C
F3, $\bar{F3}$	10A + 7.5N + 3C
F4, $\bar{F4}$	7.5A + 7.5N + 3C
Power: −12 volts	56 ma. (RDX-M): 66 ma. (RDL-M)
+12 volts	1.4 ma.(RDX-M): 1.9 ma. (RDL-M)

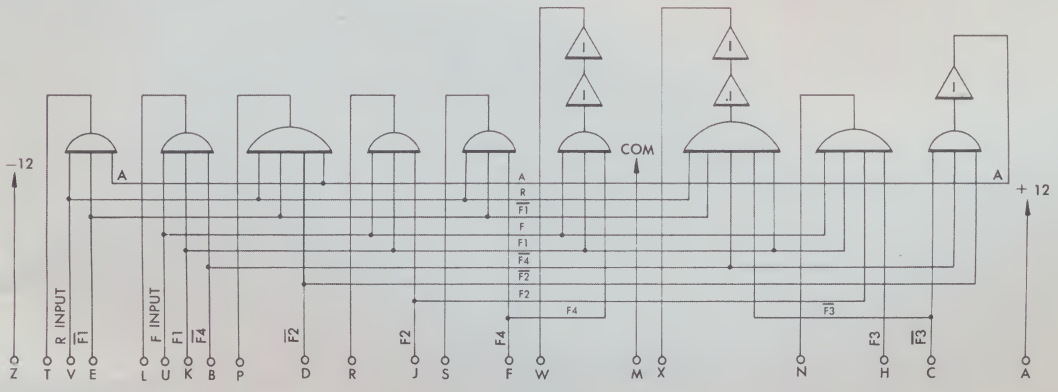


4XH-M/4XH-H BLOCK DIAGRAM



RDX-M BLOCK DIAGRAM





RDL-M BLOCK DIAGRAM

AND GATES

A26-M / A26-H

SIX—2 INPUT AND GATES

These modules provide six AND gates, each with two inputs. The A26-M operates at frequencies up to 200 kc; the A26-H at frequencies up to 1 Mc. These units will drive increased capacitive loads if the operating frequency is reduced or if the output is connected to an NPN emitter follower (Model EFA-M). Up to three gates may be used in series if the final output is restored to standard logic levels by a squaring amplifier (Models 8SA-M; 8SA-H).

MODEL NO.:	A26-M	A26-H
Type:	Six - 2 Input AND Gate	Six - 2 Input AND Gate
Input Frequency:	200 Kc maximum	1 Mc maximum
Input Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":		
(with output restoration)	−0.9 volts maximum	−0.9 volts maximum
(no output restoration)	−0.2 volts maximum	−0.2 volts maximum
Input Loading:	$2.5A + A_o + C_o$	$4.7A + A_o + C_o$
Input Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Output Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	0.3 volts more negative than input	0.3 volts more negative than input
Output Loading:	7.5A + 1.5N + 1C (at 200 Kc) 7.5A + 1.5N + 3C (at 50 Kc)	10A + 2.75N + 0.5C (at 1 Mc) 10A + 2.75N + 1.5C (at 200 Kc)
Output Rise Time:	Same as input	Same as input
Power: −12 volts	8 ma.	15.3 ma.
+12 volts	Not used	Not used

A44-M / A44-H

FOUR —4 INPUT AND GATES

These modules provide four AND gates, each with four inputs. The A44-M operates at frequencies up to 200 kc; the A44-H at frequencies up to 1 Mc. The loading and series connection techniques described for the A26 modules also apply to these modules.

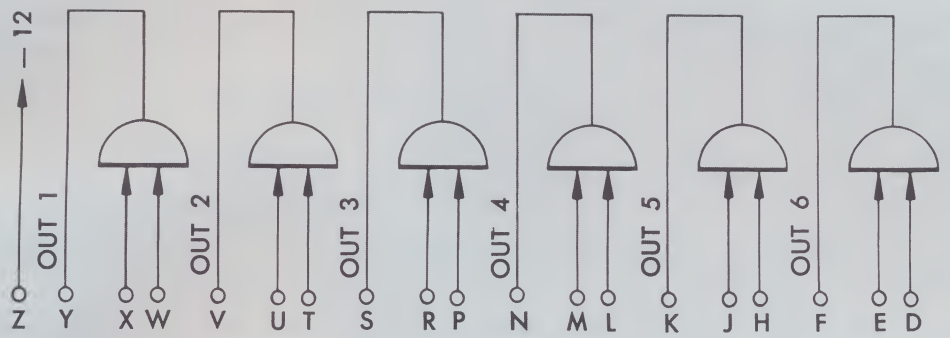
MODEL NO.:	A44-M	A44-H
Type:	Four - 4 Input AND Gates	Four - 4 Input AND Gates
Input Frequency:	200 Kc maximum	1 Mc maximum
Input Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":		
(with output restoration)	−0.9 volts maximum	−0.9 volts maximum
(no output restoration)	−0.2 volts maximum	−0.2 volts maximum
Input Loading:	$2.5A + A_o + C_o$	$4.7A + A_o + C_o$
Input Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Output Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	0.3 volts more negative than input	0.3 volts more negative than input
Output Loading:	7.5A + 1.5N + 1C (200 Kc) 7.5A + 1.5N + 3C (50 Kc)	10A + 2.75N + 0.5C (1 Mc) 10A + 2.75N + 1.5C (200 Kc)
Output Rise Time:	Same as input	Same as input
Power: −12 volts	5.3 ma.	10.2 ma.
+12 volts	Not used	Not used

A35-M / A35-H

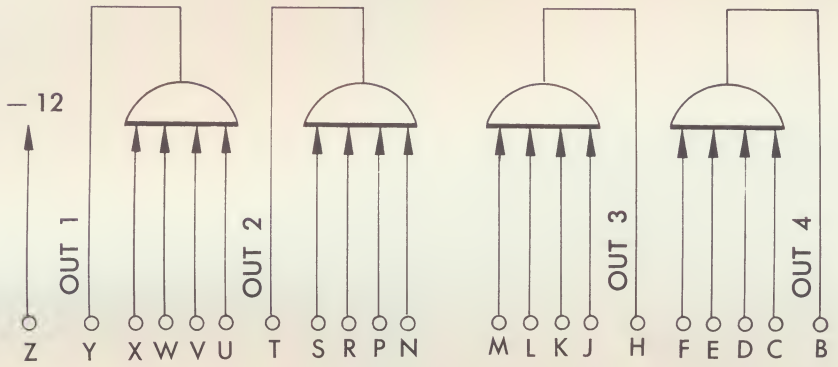
FIVE—3 INPUT AND GATES

These modules provide five AND gates, each with three inputs. The A35-M operates at frequencies up to 200 kc; the A35-H at frequencies up to 1 Mc. The loading and series connection techniques described for the A26 models also apply to these modules.

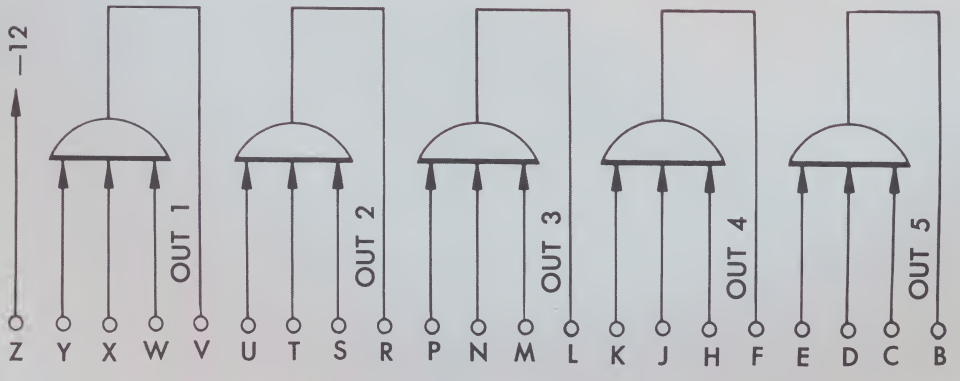
MODEL NO.:	A35-M	A35-H
Type:	Five - 3 Input AND Gate	Five - 3 Input AND Gate
Input Frequency:	200 Kc maximum	1 Mc maximum
Input Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":		
(with output restoration)	−0.9 volts maximum	−0.9 volts maximum
(no output restoration)	−0.2 volts maximum	−0.2 volts maximum
Input Loading:	$2.5A + A_o + C_o$	$4.7A + A_o + C_o$
Input Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Output Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	0.3 volts more negative than input	0.3 volts more negative than input
Output Loading:	7.5A + 1.5N + 1C (200 Kc) 7.5A + 1.5N + 3C (50 Kc)	10A + 2.75N + 0.5C (1 Mc) 10A + 2.75N + 1.5C (200 Kc)
Output Rise Time:	Same as input	Same as input
Power: −12 volts	6.6 ma.	12.8 ma.
+12 volts	Not used	Not used



A26-M / A26-H BLOCK DIAGRAM



A44-M / A44-H BLOCK DIAGRAM



A35-M / A35-H BLOCK DIAGRAM

AND GATES

6GE-H
GATE EXPANDER

The Model 6GE-H provides six pairs of diodes. The negative sides of each pair are tied together. These outputs can be connected to the output of standard AND gates to provide additional input terms. The diode pairs can also be tied to external resistors to form complete, independent gates. The 6GE-H can be used with either 200 Kc or 1 Mc logic modules.

MODEL NO.:	6GE-H	
Type:	Six - 2 Input Gate Expanders	
Input Frequency:	200 Kc operation	1 Mc operation
Input Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero": (with output restoration)	−0.9 volts maximum	−0.9 volts maximum
(no output restoration)	−0.2 volts maximum	−0.2 volts maximum
Input Loading: (when used with standard AND gates)	$2.5A + A_o + C_o$	$4.7A + A_o + C_o$
Input Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Output Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	0.3 volts more negative than input	0.3 volts more negative than input
Output Rise Time:	Same as input	Same as input
Power: −12 volts	Not required	Not required
+12 volts	Not required	Not required

NAND GATES

S26-M / S26-H
SIX—2 INPUT NAND GATES

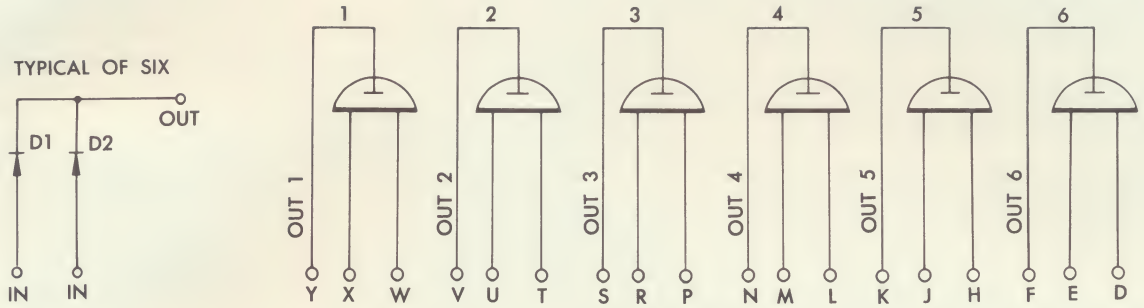
These modules provide six NAND Gates, each with two inputs. The S26-M operates at frequencies up to 200 kc; the S26-H at frequencies up to 1 Mc. Each circuit consists of a two input AND gate followed by an inverter. The output of each gate is buffered and amplified which eliminates level shift problems when many gates are connected in series. The node of one circuit is brought out to the connector.

MODEL NO.:	S26-M	S26-H
Type:	Six - 2 Input NAND Gate	Six - 2 Input NAND Gate
Input Frequency:	200 Kc maximum	1 Mc maximum
Input Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Input Loading:	2.5A	4.75A
Input Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Output Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts	−0.1 ±0.1 volts
Output Loading:	10A + 6N + 3C (200 Kc) 10A + 6N + 5C (50 Kc)	20A + 11N + 0.6C (1 Mc) 20A + 11N + 3C (200 Kc)
Power: −12 volts	36 ma.	68 ma.
+12 volts	1.4 ma.	2.2 ma.

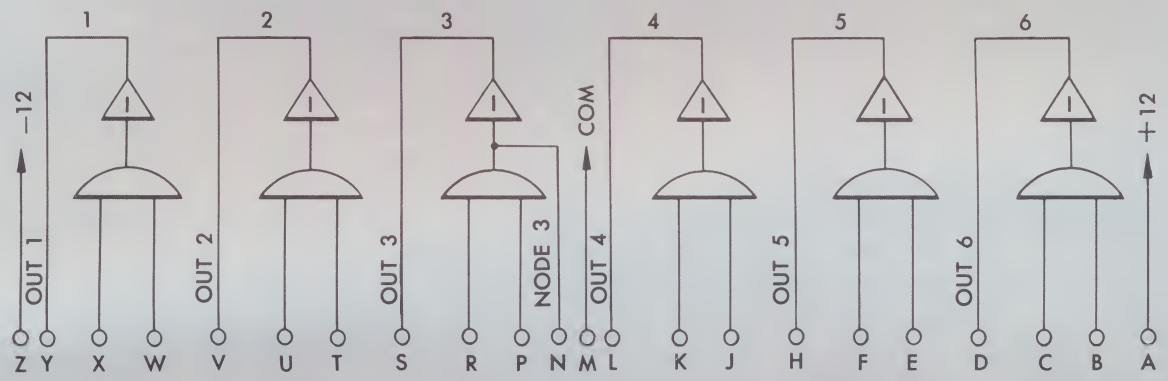
S34-M / S34-H
FOUR—3 INPUT NAND GATES

These modules provide four NAND Gates, each with three inputs. The S34-M operates at frequencies up to 200 kc; the S34-H at frequencies up to 1 Mc. Each circuit consists of a three input AND gate followed by an inverter. The output of each gate is buffered and amplified, eliminating level shift problems when many gates are connected in series. The nodes of three circuits are brought out to the connector.

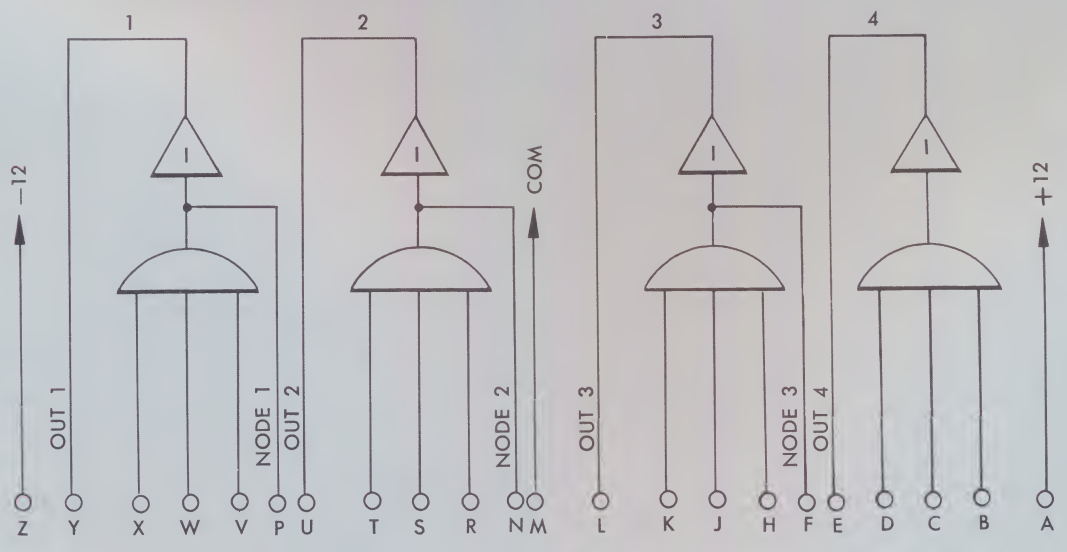
MODEL NO.:	S34-M	S34-H
Type:	Four − 3 Input NAND Gate	Four − 3 Input NAND Gate
Input Frequency:	200 Kc maximum	1 Mc maximum
Input Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Input Loading:	2.5A	4.75A
Input Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Output Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts	−0.1 ±0.1 volts
Output Loading:	10A + 6N + 3C (200 Kc) 10A + 6N + 5C (50 Kc)	20A + 11N + 0.6C (1 Mc) 20A + 11N + 3C (200 Kc)
Power: −12 volts	24 ma.	45 ma.
+12 volts	0.9 ma.	1.5 ma.



6GE-H BLOCK DIAGRAM



S26-M/S26-H BLOCK DIAGRAM



S34-M/S34-H BLOCK DIAGRAM

OR GATES

026-L/035-L/044-L
OR GATES

The three types of OR Gate logic modules provide three different configurations:

026-L Six OR gates, each with two inputs
035-L Five OR gates, each with three inputs
044-L Four OR gates, each with four inputs

These gates are recommended for use with NOR logic and in other DC applications. They are not recommended for use with capacitive loads.

MODEL NO.:	026-L	035-L	044-L
Type:	Six-2 Input OR Gates	Five-3 Input OR Gates	Four-4 Input OR Gates
Input Frequency:	50 kc maximum	50 kc maximum	50 kc maximum
Input Levels:			
Logical "One":	−10 ±2 volts	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.8 volts max.	−0.8 volts max.	−0.8 volts max.
Input Loading:	$1N + N_o + C_o$	$1N + N_o + C_o$	$1N + N_o + C_o$
Output Levels:			
Logical "One":	−10 ±2 volts	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	0.3 volts more positive than input	0.3 volts more positive than input	0.3 volts more positive than input
Output Loading:	10N + 2C (DC loads only)	10N + 2C (DC loads only)	10N + 2C (DC loads only)
Power: −12 volts	Not used	Not used	Not used
+12 volts	1.32 ma.	1.2 ma.	0.88 ma.

EO-L
THREE "EXCLUSIVE OR" GATES

The Model EO-L provides three independent "Exclusive OR" circuits, each with four inputs. These circuits are useful in performing the following logical operations: "Exclusive OR", half adders-subtractors, digital comparators, odd-even parity detectors, and logical multiplexers.

Each half of the three separate circuits has two inputs. The logic equations for each circuit can be represented as follows:

With independent inputs (D, E, F, G):

$$C = (D+E)(F+G) = DF + DG + EF + EG$$

With two inputs and their complements:

1. A and B grouped together: $\overline{A}$ and $\overline{B}$ grouped together
$$C = A\overline{B} + \overline{A}B$$
2. A and $\overline{B}$ grouped together: $\overline{A}$ and B grouped together
$$C = AB + \overline{A}\overline{B}$$

MODEL NO.:	EO-L
Type:	Three "Exclusive OR" Gates
Input Frequency:	50 kc maximum
Input Levels:	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts
Input Loading:	1.5N per input
Input Rise Time:	Not critical
Output Levels:	
Logical "One"	−10 ±2 volts
Logical "Zero"	−0.1 ±0.1 volts
Output Loading:	5A + 6N + 5C (DC loads only)
Power: −12 volts	22 ma.
+12 volts	1.4 ma.

NOR GATES

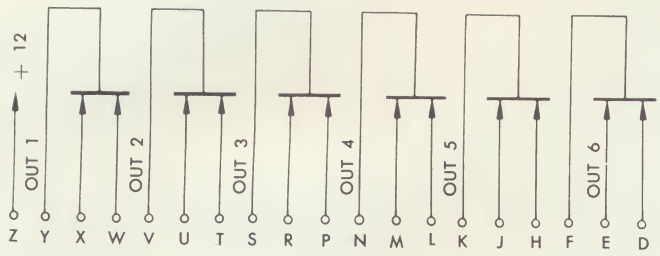
N26-L/N35-L/N44-L
NOR GATES

The three types of NOR logic modules provide three configurations:

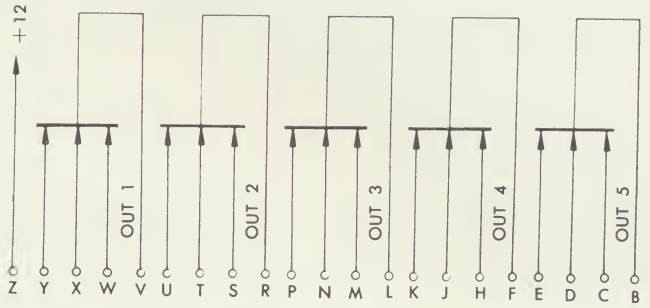
N26-L Six NOR gates, each with two inputs
N35-L Five NOR gates, four 3 input, one 2 input
N44-L Four NOR gates, three 4 input, one 3 input

These gates can be used in all DC logic applications. For AC applications two inputs may be connected in parallel for the signal input. This provides additional drive to insure the required rise time at the output.

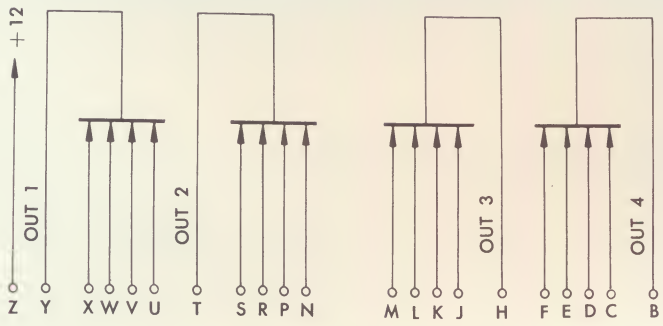
MODEL NO.:	N26-L	N35-L	N44-L
Type:	Six-2 Input NOR Gates	Four-3 Input NOR Gates, one 2 input	Three-4 Input NOR Gates, one 3 input
Input Frequency:	50 Kc maximum	50 Kc maximum	50 Kc maximum
Input Levels:			
Logical "One":	−10 ±2 volts	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Input Loading:	1.5N	1.5N	1.5N
Input Rise Time:	Non-critical	Non-critical	Non-critical
Input Fall Time:			
DC Output Loads	Non-critical	Non-critical	Non-critical
AC Output Loads	2 μsec. maximum	2 μsec. maximum	2 μsec. maximum
Output Levels:			
Logical "One":	−10 ±2 volts	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts	−0.1 ±0.1 volts	−0.1 ±0.1 volts
Output Loading:			
Single Input:	5A + 6N + 5C (DC loads only)	5A + 6N + 5C (DC loads only)	5A + 6N + 5C (DC loads only)
Two Parallel Inputs:	5A + 6N + 3C (AC or DC loads)	5A + 6N + 3C (AC or DC loads)	5A + 6N + 3C (AC or DC loads)
Power: −12 volts	33 ma.	27 ma.	22 ma.
+12 volts	0.9 ma.	0.8 ma.	0.6 ma.



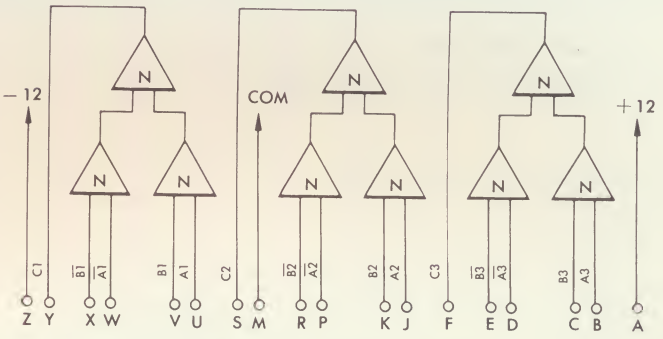
026-L BLOCK DIAGRAM



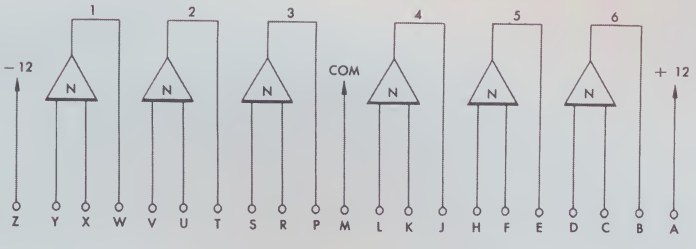
0-35-L BLOCK DIAGRAM



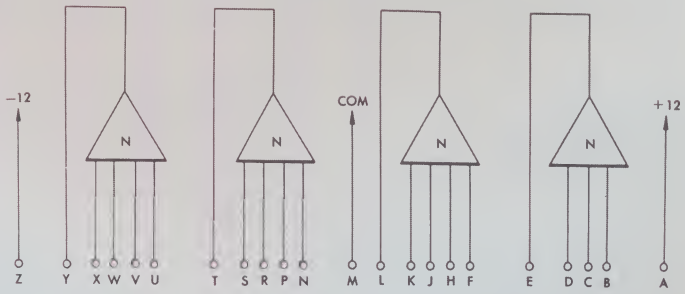
044-L BLOCK DIAGRAM



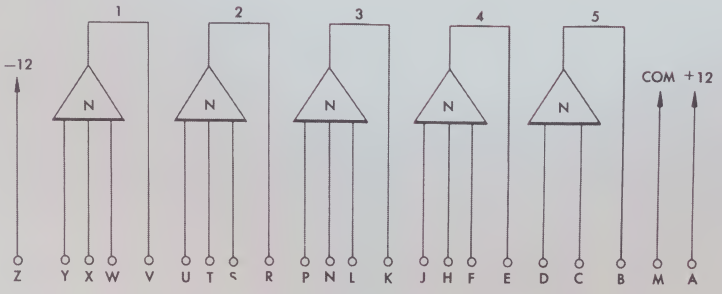
EO-L BLOCK DIAGRAM



N26-L BLOCK DIAGRAM



N44-L BLOCK DIAGRAM



N35-L BLOCK DIAGRAM

AMPLIFIERS

8IA-M / 8IA-H
8 INVERTING AMPLIFIERS

These modules provide eight Inverting Amplifiers per card. The 8IA-M operates at frequencies up to 200 kc; the 8IA-H at frequencies up to 1 Mc. With the proper input signals, these units will operate with all standard logic elements.

MODEL NO.:	8IA-M	8IA-H
Type:	Eight Inverting Amplifiers	Eight Inverting Amplifiers
Input Frequency:	200 kc	1 Mc
Input Logic Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Input Loading:	1.5N + 1C	2.75N + 0.2C
Input Rise Time:	1.0 μsec. maximum	0.2 μsec. maximum
Output Logic Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts	−0.1 ±0.1 volts
Output Loading:	7.5A + 6N + 3C (at 200 kc) 7.5A + 6N + 5C (at 50 kc	15A + 11N + 0.6C (at 1 Mc) 15A + 11N + 3C (at 200 kc)
Power: −12 volts	44 ma.	80 ma.
+12 volts	0.7 ma.	1.0 ma.

8SA-M / 8SA-H
8 SQUARING AMPLIFIERS

These modules provide eight non-inverting amplifiers which can be used to square or level-restore standard logic signals. The 8SA-M operates at frequencies up to 200 kc; the 8SA-H at frequencies up to 1 Mc.

MODEL NO.:	8SA-M	8SA-H
Type:	8-Squaring Amplifiers	8-Squaring Amplifiers
Input Frequency:	200 kc	1 Mc
Input Levels:		
Logical "One":	−7 volts to − 12 volts	−7 volts to − 12 volts
Logical "Zero":	0 volts to −1.25 volts	0 volts to −1.25 volts
Input Loading:	1.5N + 1C	2.75N + 0.2C
Input Rise Time:	10 μsec. maximum[1]	2.0 μsec. maximum[2]
Output Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.2 ±0.2 volts	−0.2 ±0.2 volts
Output Loading:	25A + 24N + 10C	100A + 24N + 2C (1 Mc) 100A + 24N + 10C (200 kc)
Power: −12 volts	200 ma.	226 ma.
+12 volts	7.3 ma.	12 ma.

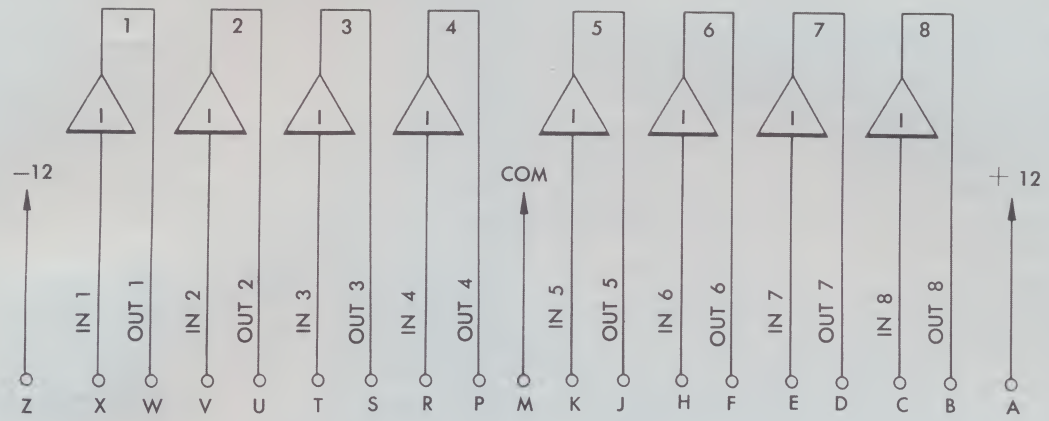
NOTE: 1. Maximum input rise time for 0.5 μsec. output rise time.

NOTE: 2. Maximum input rise time for 0.1 μsec. output rise time.

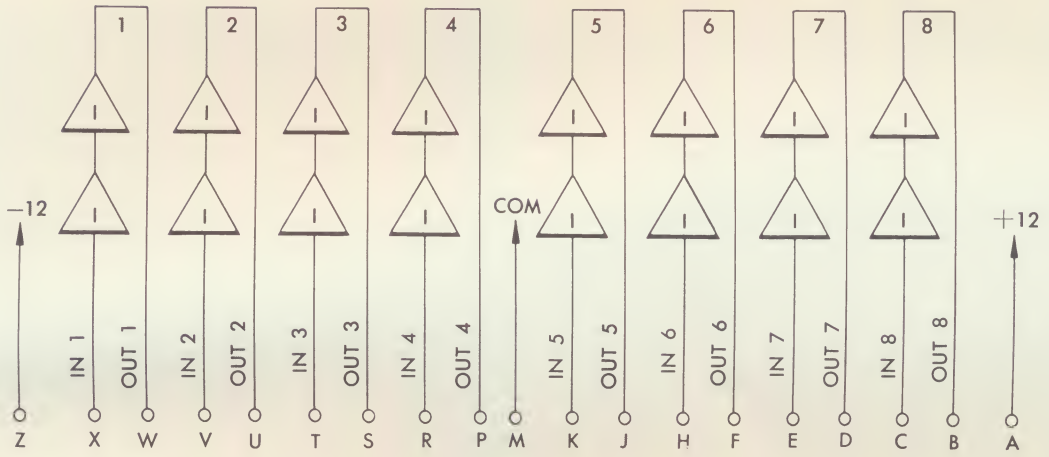
4CD-H
4 CLOCK DRIVERS

The Model 4CD-H Clock Driver module consists of four NAND circuits which provide fast rising, low impedance output signals. These signals can be used as the synchronizing clock for large module assemblies which place heavy loads on the clock signal. Each of the circuits is a three-input NAND gate with high output drive capability. The output signals can be used with both 200 kc and 1 Mc standard logic elements.

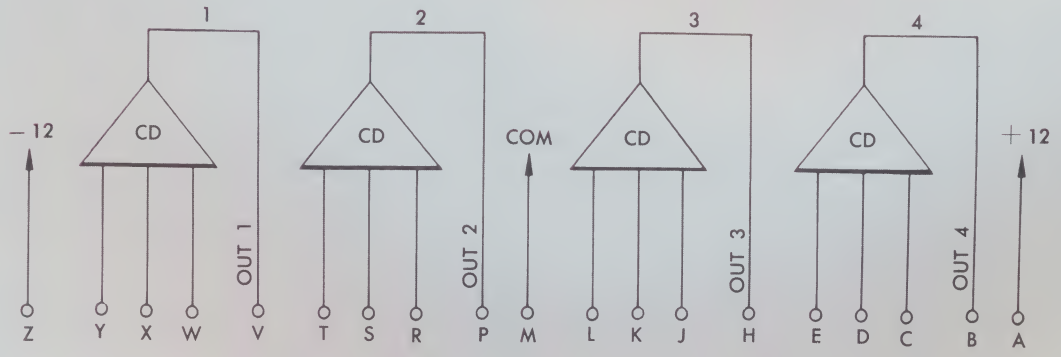
MODEL NO :	4CD-H	
Type:	4 Clock Drivers (each — 3 input NAND)	
Input Frequency:	200 kc	1 Mc
Input Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Input Loading:	4.75A	4.75A
Input Rise Time:	0.5 μsec. maximum	0.1 μsec. maximum
Input Fall Time:	2.0 μsec. maximum	0.2 μsec. maximum
Output Levels:		
Logical "One":	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.2 ±0.2 volts	−0.2 ±0.2 volts
Output Loading:	20A + 100N + 50C	20A + 100N + 5C
Output Rise Time: (with maximum C load)	0.5 μsec. maximum	0.1 μsec. maximum
Power: −12 volts	125 ma. (full N load) 45 ma. (no N load)	125 ma. (full N load) 45 ma. (no N load)
+12 volts	1.5 ma.	1.5 ma.



8IA-M / 8IA-H BLOCK DIAGRAM



8SA-M / 8SA-H BLOCK DIAGRAM



4CD-H BLOCK DIAGRAM

AMPLIFIERS

TIAN-M / TIAP-M
10 LEVEL SHIFT AMPLIFIERS

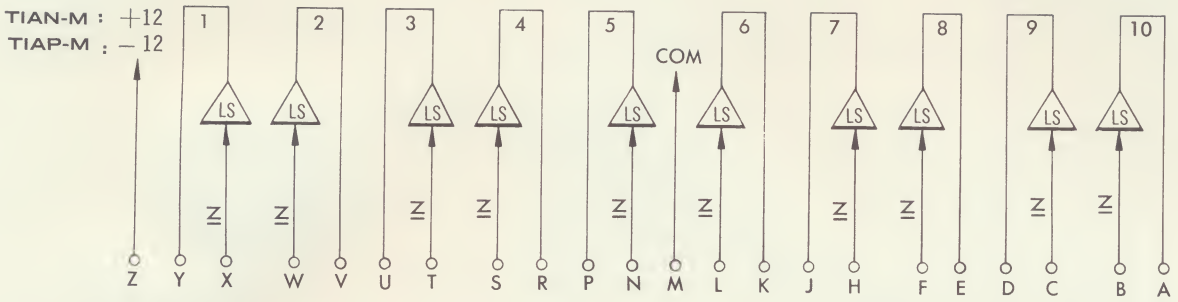
The Model TIAP-M provides 10 level shift amplifiers for converting NPN logic levels (positive) to PNP logic levels (negative). The Model TIAN-M converts PNP levels (negative) to NPN levels (positive). Typical applications include logic level transformation, interface amplification, level standardization, etc.

MODEL NO.:	TIAP-M	TIAN-M
Type:	NPN to PNP	PNP to NPN
Input Frequency:	200 kc maximum	200 kc maximum
Input Rise Time:	1.0 μsec. max. (Logic 0 to 1)	1.0 μsec. max. (Logic 1 to 0)
Input Fall Time:	1.0 μsec. max. (Logic 1 to 0)	1.0 μsec. max. (Logic 0 to 1)
Input Levels:	+10 ±2 volts (Logic 1) +0.25 ±0.25 volts (Logic 0)	−10 ±2 volts (Logic 1) −0.25 ±0.25 volts (Logic 0)
Input Loading:	12K ohms shunted by 100 pf to ground (Logic 0) 12K ohms shunted by 100 pf in series with 27K ohms to −12 volts (Logic 1)	2.75 N + 1C
Output Levels:	−10 ±2 volts (Logic 1) −0.1 ±0.1 volts (Logic 0)	+10 ±2 volts (Logic 1) +0.1 ±0.1 volts (Logic 0)
Output Loading:	6N + 7.5A + 3C (at 200 kc) 6N + 7.5A + 5C (50 kc)	1.5 ma. maximum to ground. 4 ma. maximum to +20 volts maximum 300 pf to ground maximum
Output Fall Time:		0.5 μsec. max. (Logic 1 to 0)
Power: −12 volts	59 ma.	Not required
+12 volts	Not required	59 ma.

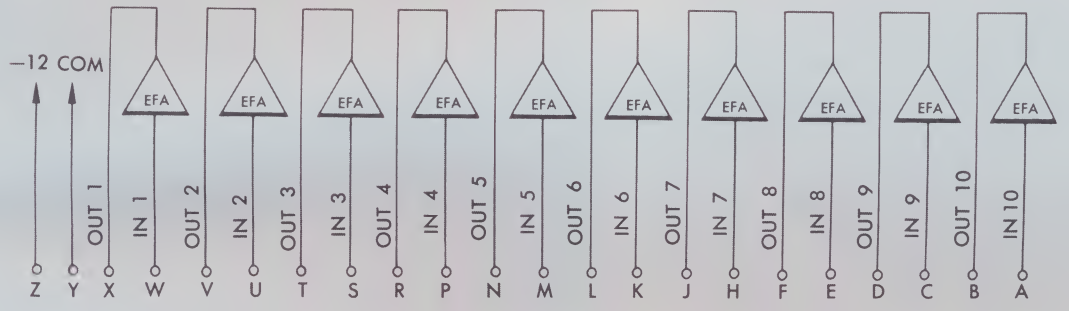
EFA-M / EFN-M
TEN EMITTER FOLLOWERS

These modules are useful in situations where the output load exceeds the driving capability of standard logic elements. The Model EFN-M permits increased current loads to Common (N loads, such as NOR logic). The Model EFA-M permits increased loads to negative voltages (A loads, such as AND gates). The Model EFA-M also permits an increase of capacitive loading. Both units are designed for 200 kc operation.

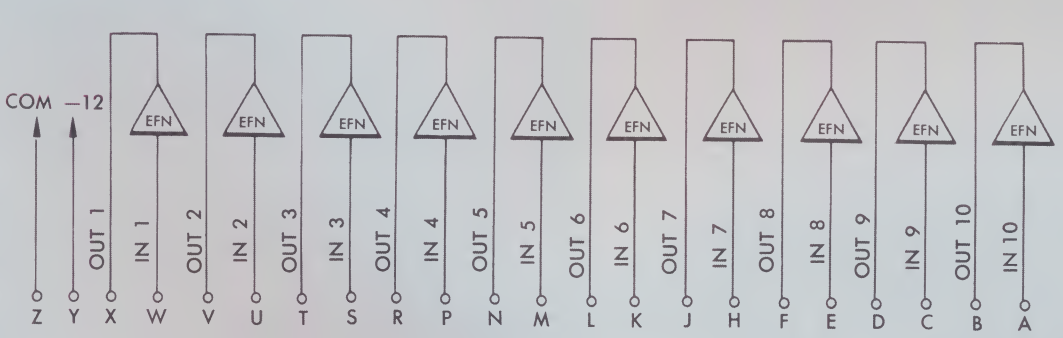
MODEL NO.:	EFA-M	EFN-M
Type:	10 Emitter Followers	10 Emitter Followers
Input Frequency:	200 kc maximum	200 kc maximum
Input Levels:		
Logical "ONE"	−10 ±2 volts	−10 ±2 volts
Logical "ZERO"	−0.1 ±0.1 volts	−0.25 ±0.25 volts
Input Loading:	0.5A + Ao/25	0.5N + No/25
Input Rise Time:	0.5 sec. maximum	0.5 sec. maximum
Input Fall Time:	Not critical	Not critical
Output Levels:		
Logical "ONE"	−10 ±2 volts	−10 ±2 volts
Logical "ZERO"	−0.25 ±0.25 volts	−0.1 ±0.1 volts
Output Loading:		
	50A + 6N + 5C (200 kc)	80N + 1C (200 kc, DC loads only)
	50A + 6N + 20C (50 kc)	80N + 3C (50 kc, DC loads only)
Power (per circuit)		
−12 volts	52 ma. (full load)	230 ma. (full load)
	52 ma. (no load)	52 ma. (no load)



TIAN-M / TIAP-M BLOCK DIAGRAM



EFA-M BLOCK DIAGRAM



EFN-M BLOCK DIAGRAM

DECODERS

DLM-D

4 BIT BCD TO 10 LINE DECIMAL DECODER DRIVER

The Model DLM-D provides the logic to convert one decimal digit in 8421 BCD format to one-out-of-10 line decimal. A power amplifier on each of the 10 output lines develops up to 120 milliamperes for driving visual displays, monitor lamps, or small relays (if properly suppressed). Both true and false inputs are required for each bit of the BCD character.

MODEL NO.:	**DLM-D**
Type:	Decoder-Lamp Driver (4 bit BCD to 10 line decimal)
Input Frequency:	1 kc*
Input Levels:	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts
Input Loading:	
F1 and $\overline{F1}$	1A
F2 and $\overline{F2}$	2A
F3 and $\overline{F3}$	2A
F4 and $\overline{F4}$	1A
Recommended Lamps:	G.E. 1813 (100 ma. 14v) 1829 (70 ma. 28v) 330 (80 ma. 14v) 327 (40 ma. 28v)
Output:	120 ma. maximum at −30 volts maximum
Power: −12 volts	48 ma.
+12 volts	8.0 ma.
Lamp Power Supply:	−30 volts maximum

*NOTE: Maximum switching rate of output is 1 Kc, however, response of indicator lamps is 10 to 20 cps. Output may be driven at 1 Kc but indicators will not respond until steady state conditions exist.

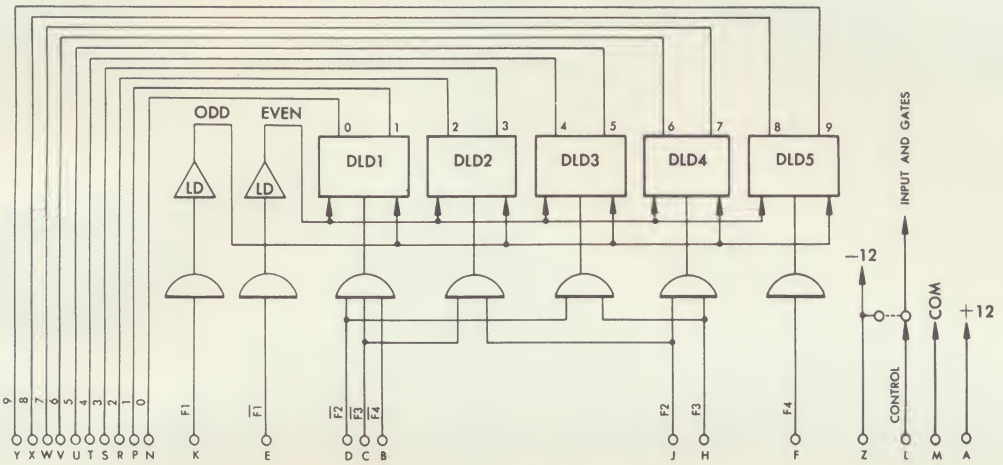
DNX-D

4 BIT BCD TO 10 LINE DECIMAL DECODER-NIXIE DRIVER

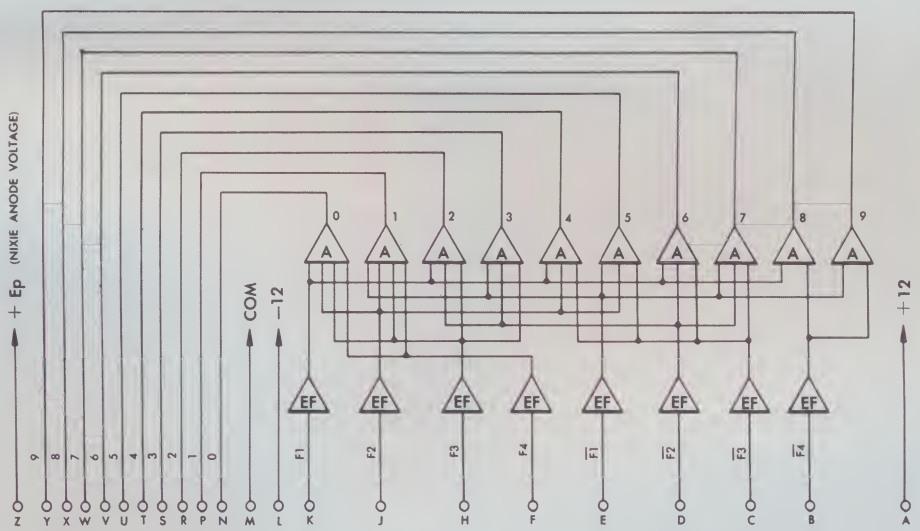
The Model DNX-D provides the logic to convert one decimal digit in 8421 BCD format to one-out-of-10 line decimal. A power amplifier on each of the output lines provide the drive capability for a Nixie tube visual display. Both true and false inputs are required for each bit of the BCD character.

MODEL NO.:	**DNX-D**
Type:	Decoder-Nixie Driver
Input Frequency:	1 Kc*
Input Levels:	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts
Input Loading:	1N (for each true or false input)
Recommended Indicators:	
Nixie Standard Types	B5092, 8037 (B5031), 6844A
Nixie Miniature Types	7009, 7977 (B4032), B4081
Recommended Nixie Tube Plate Dropping Resistors (RL)	
Nixie Type B5092	RL = 10 K ohms
Nixie 8037 (B5031)	RL = 10 K ohms
6844A	RL = 15 K ohms
7009	RL = 68 K ohms
7977 (B4032)	RL = 15 K ohms
B4081	RL = 68 K ohms
Output Loading:	3 ma. maximum
Power: −12 volts	33 ma. maximum
+12 volts	10 ma. maximum
Nixie Supply Voltage:	+170 volts, 7.0 ma. maximum

*NOTE: Maximum switching rate of output is 1 Kc, however, response of Nixie displays is 10 to 20 cps. Output may be driven at 1 Kc but indicators will not respond until steady state conditions exist.



DLM-D BLOCK DIAGRAM



DNX-D BLOCK DIAGRAM

DECODERS

BTM-L

3 BIT BINARY TO 8 LINE DECIMAL DECODER

The type BTM-L provides NOR logic to decode three bits of binary information to a one-out-of-eight line code. A fourth input line is provided for control purposes. The control input may be connected to logic or directly to a fourth binary bit to permit complete decoding using two BTM-L cards.

MODEL NO.:	BTM-L
Type:	NOR Decoder (3 bit binary to 1 out of 8 lines)
Input Frequency:	50 Kc
Input Levels:	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts
Input Loading:	6N (for each F or $\overline{F}$ input)
Input Rise Time:	Non-Critical
Output Levels:	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts
Output Loading:	5A + 6N + 5C (DC loads only)
Power: −12 volts	44 ma.
+12 volts	1.4 ma.

8LM-D

3 BIT BINARY TO 8 LINE DECIMAL DECODER-DRIVER

The Model 8LM-D provides the logic to convert three bits of binary data to a one-out-of-8 line format. A power amplifier on each output line provides 120 milliamperes for driving visual displays, monitor lamps, or small relays (if properly suppressed). This module is useful in recording or displaying binary data in actual form. Both true and false inputs are required for each bit of the BCD character.

MODEL NO.:	8LM-D
Type:	Decoder-Lamp Driver (3 bit binary to 1 out of 8 lines)
Input Frequency:	1 Kc*
Input Levels:	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts
Input Loading:	6A (for each F or $\overline{F}$ input)
Recommended Lamps:	G.E. 1813 (100 ma. 14v) 1829 (70 ma. 28v) 330 (80 ma. 14v) 327 (40 ma. 28v)
Output:	120 ma. maximum at −30 volts maximum
Power: −12 volts	19 ma.
+12 volts	1.1 ma.
Lamp Power Supply:	−30 volts

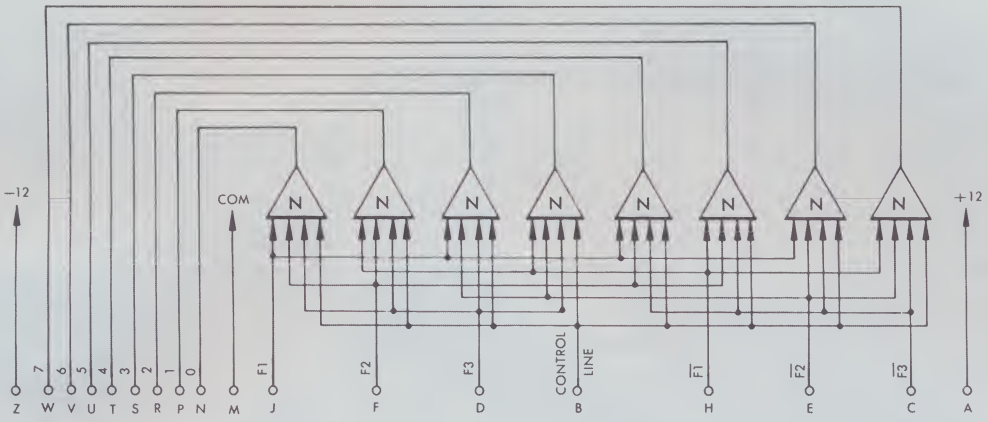
*NOTE: Maximum switching rate of output is 1 Kc, however, response of indicator lamp is 10 to 20 cps. Output may be driven at 1 Kc but indicators will not respond until steady state conditions exist.

BDM-L

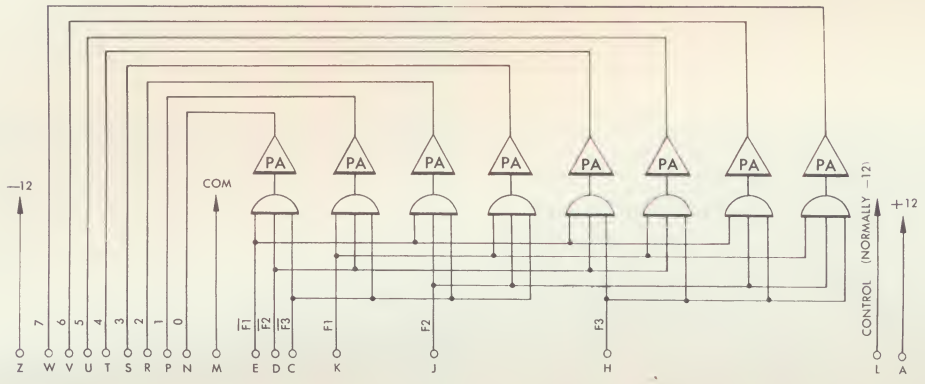
4 BIT BCD TO 10 LINE DECIMAL DECODER

The Model BDM-L provides NOR logic for converting one decimal digit in 8421 BCD format to one-out-of-10 line decimal. The unit operates at frequencies up to 50 Kc. Both true and false inputs are required for each bit of BCD data.

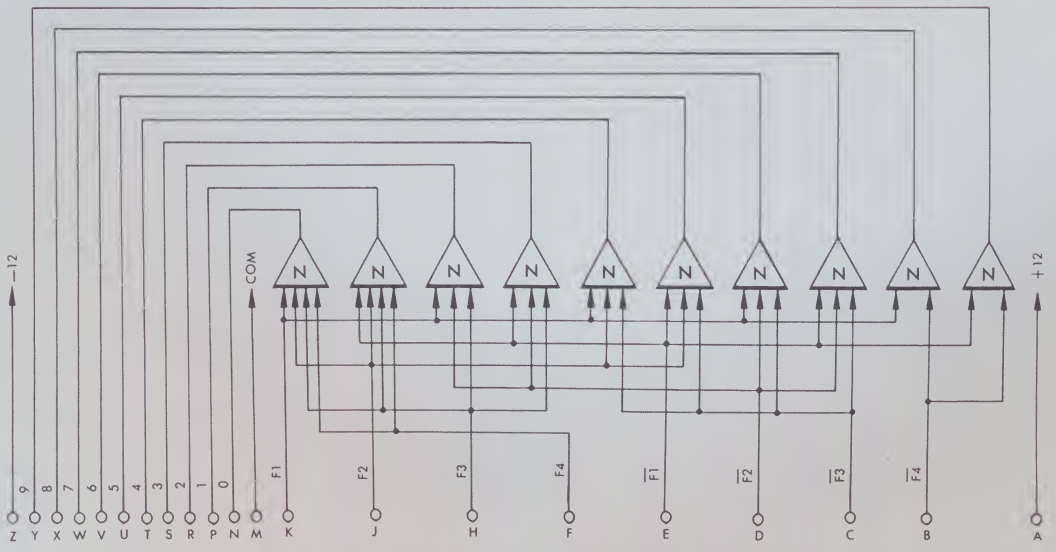
MODEL NO.:	BDM-L
Type:	NOR Decoder (4 bit BCD to 1 out of 10 lines)
Input Frequency:	50 Kc maximum
Input Levels:	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.25 ±0.25 volts
Input Loading:	
F1 and $\overline{F1}$	7.5N
F2 and $\overline{F2}$	6N
F3 and $\overline{F3}$	6N
F4 and $\overline{F4}$	3N
Input Rise Time:	Non-critical
Output Levels:	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts
Output Loading:	5A + 6N + 5C (DC loads only)
Power: −12 volts	49 ma.
+12 volts	1.6 ma.



BTM-L BLOCK DIAGRAM



8LM-D BLOCK DIAGRAM



BDM-L BLOCK DIAGRAM

PULSE GENERATORS

2AM-M
2 ADJUSTABLE SYNCHRONOUS MULTIVIBRATORS

The Model 2AM-M provides two adjustable, buffered multivibrators, both of which allow external synchronization. Each circuit is adjustable over a range of ±33% of center frequency (2:1) from 100 cps to 100 Kcps. The nominal center frequency is 100 Kc without external capacitors. Suitable external timing capacitors may be used for lower frequency applications.

MODEL NO.:	2AM-M
Type:	2 Adjustable Multivibrators
Nominal Center Frequency:	100 Kc (without external timing capacitor)
Minimum Center Frequency:	100 cps (with suitable external capacitor)
Frequency Adjustment Range:	±33% nominal center frequency (2:1 range)
Sync. Gate Amplitude:	
Logical "One"	−10 ±2 volts (multivibrator running)
Logical "Zero"	−0.25 ±0.25 volts (multivibrator inhibited)
Synch. Gate Input Loading:	1.5N + 1C
Output Loading:	5N + 7.5A + 3C (each output)
Power: −12 volts	54 ma.
+12 volts	0.6 ma.

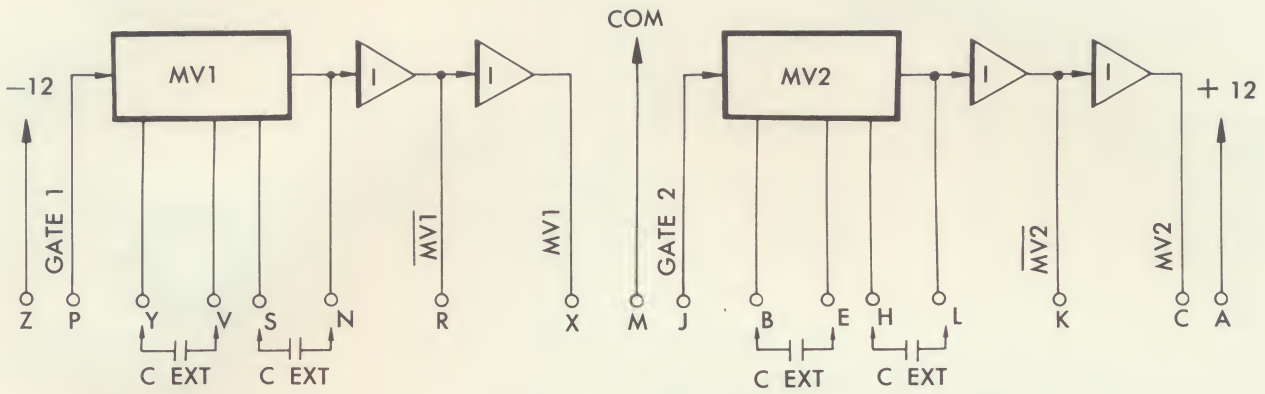
4AS-M/4AS-H/4SS-M
4 SINGLE SHOTS

These modules each provides four independent one shot multivibrators. The Model 4AS-M multivibrators have a nominal pulse width of 10 microseconds adjustable over a 2:1 range (nominal pulse width ±33%) by means of potentiometers mounted on the board. The Model 4AS-H is identical except that the nominal pulse width is 1.0 microseconds.

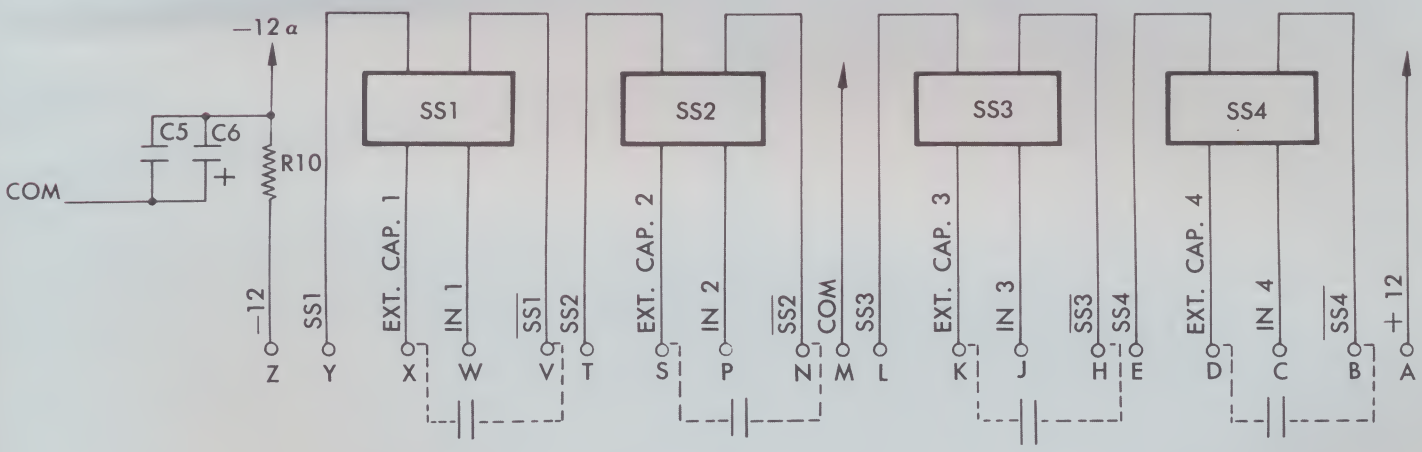
The Model 4SS-M is identical to the Model 4AS-M except that the potentiometers are replaced by a fixed resistor. All three units have provisions for connecting external capacitors to further extend the pulse width range. Both true and false outputs are available from each circuit.

MODEL NO.:	4AS-M	4AS-H	4SS-M
Type:	4 Adjustable One-Shots	4 Adjustable One-Shots	4 One-Shots Fixed Delay
Input Amplitude:			
Logical "One"	−10 ±2 volts	−10 ±2 volts	−10 ±2 volts
Logical "Zero"	−0.25 ±0.25 volts	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Input Rise Time: (Trigger Edge):	0.5 μsec. maximum	0.1 μsec. max.	0.5 μsec. maximum
Input Loading:	2.2C	0.5C	2.2C
Nominal Pulse Width:	10 μsec.	1 μsec.	10 μsec.
Pulse Width Adjustment Range:	2:1 (Nominal ±33%)	2:1 (Nominal ±33%)	None
Minimum Pulse Recovery Time:	80% of pulse width	80% of pulse width	80% of pulse width
Output Levels:			
Logical "One":	−10 ±2 volts	−10 ±2 volts	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts	−0.1 ±0.1 volts	−0.1 ±0.1 volts
Output Loading:	10A + 6N + 5C[1]	15A + 9N + 1C[2]	10A + 6N + 5C[1]
Power: −12 volts	48 ma.	72 ma.	48 ma.
+12 volts	1.0 ma.	2.0 ma.	1.0 ma.

NOTES: (1) For pulse widths greater than 500 μsec., the output will drive DC loads only.
(2) For pulse widths greater than 50 μsec., the output will drive DC loads only.



2AM-M BLOCK DIAGRAM



4AS-M/4AS-H/4SS-M BLOCK DIAGRAM

PULSE GENERATORS

KG-100M / KG-1000H
CRYSTAL CONTROLLED OSCILLATORS

The Model KG-100M is a crystal controlled oscillator with an output frequency of 100 kc; the Model KG-1000H provides an output frequency of 1 Mc. The output frequencies are accurate to 0.001% under normal laboratory conditions. The outputs are square waves at standard logic levels able to directly drive either AC or DC coupled logic. Trimming capacitors are provided to permit accurate setting of the output frequency.

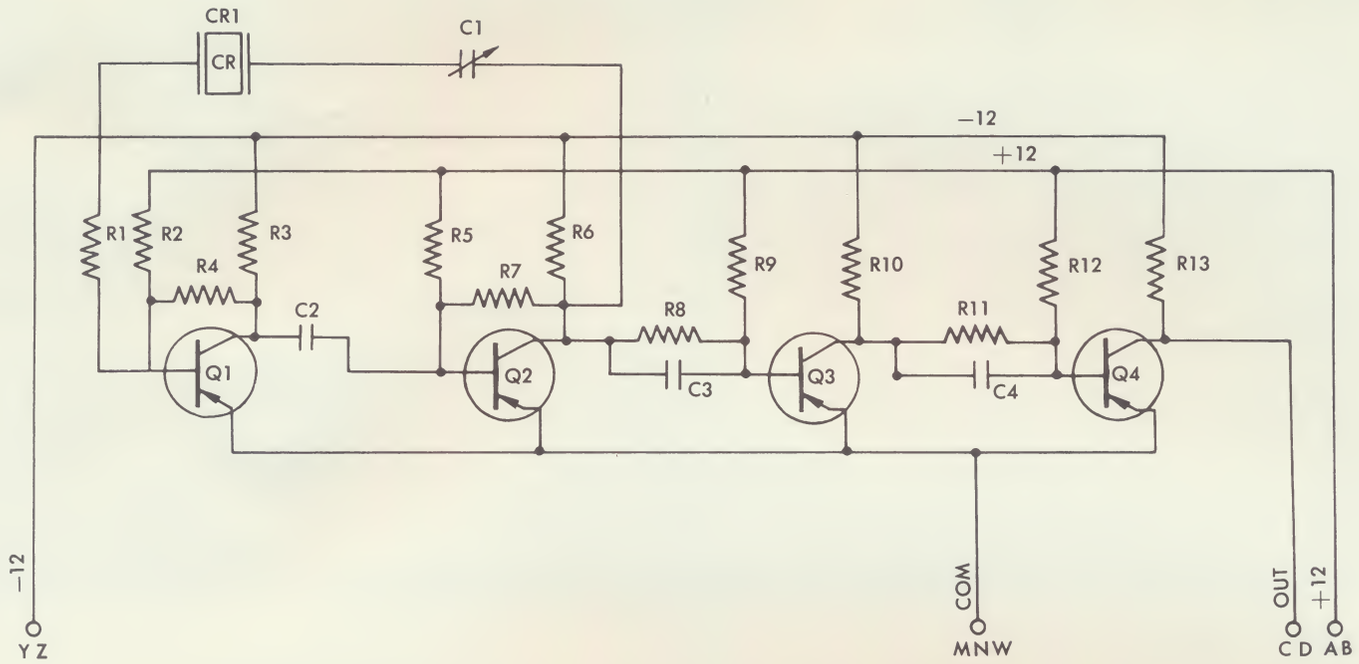
MODEL NO.:	KG-100M	KG-1000H
Type:	Xtal Oscillator	Xtal Oscillator
Output Frequency:	100 kc ±0.001% (at 25°C)	1 Mc ±0.001% (at 25°C)
Frequency Stability:	±0.01% (0 - 50°C)	±0.01% (0 - 50°C)
Operating Temp. Range:	0°C to 50°C	0°C to 50°C
Output Waveform:	Square wave	Square wave
Output Levels:	−0.2 ±0.2 volts −10 ±2 volts	−0.2 ±0.2 volts −10 ±2 volts
Output Loading:	25A + 24N + 10C	100A + 24N + 2C (at 1 Mc) 100A + 24N + 10C (200 kc)
Power: −12 volts	30 ma.	34 ma.
+12 volts	1.0 ma.	1.6 ma.

4AT-H
4 SCHMITT TRIGGERS

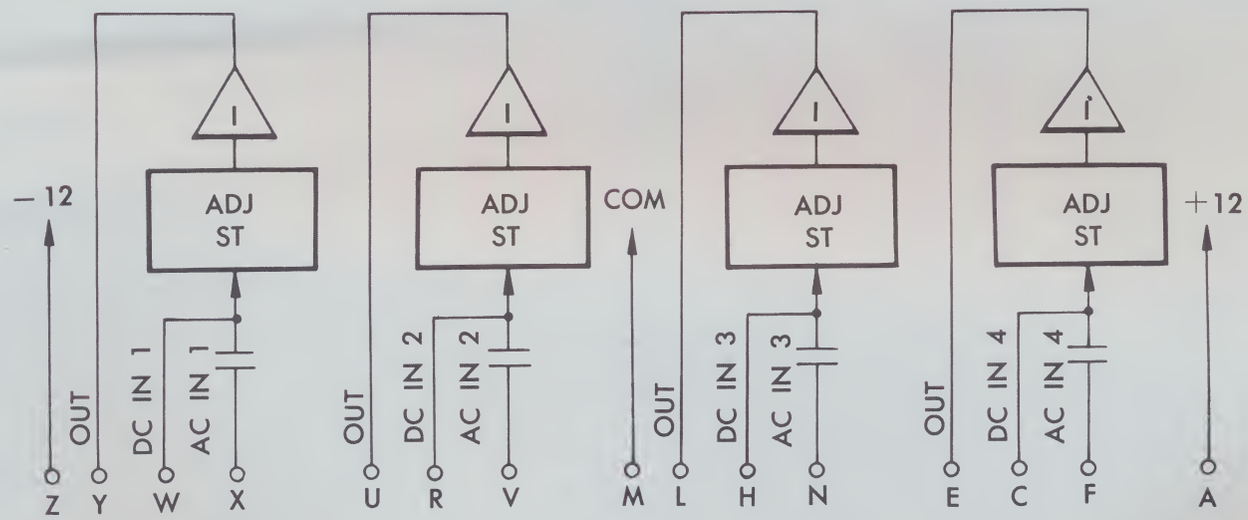
The Type 4AT-H Four Schmitt Triggers unit provides four independent sections consisting of a Schmitt Trigger capable of operation from 50 cps to over 1 Mc on the AC coupled input and from DC to over 1 Mc on the DC coupled input. A potentiometer is provided for each section to permit adjustment of the trigger level to either a positive, zero, or negative input voltage. An output amplifier is provided with each section for high load driving capability.

MODEL NO.:	4AT-H
Type:	4 Schmitt Triggers
Input Frequency	
AC Input	50 cps — 1 Mc (sinewave)
DC Input	DC — 1 Mc (sinewave)
Input Loading:	
DC Input	10K shunted by 50 pf
AC Input	10K shunted by 56 pf in series with 0.25 μf
Source Impedance:	5K maximum
Hysteresis:	1.5 volts minimum 2.5 volts maximum
Input Amplitude:	1.0 volts rms sinewave minimum 7.0 volts rms sinewave maximum
Output Levels:*	
Logical "One":	−10 ±2 volts
Logical "Zero":	−0.1 ±0.1 volts
Output Loading:	15A + 11N + 1C (at 1 Mc, 0.1 μsec. rise time at output) 15A + 11N + 5C (at 200 kc, 0.5 μsec. rise time at output)
Power: −12 volts	82 ma. maximum
+12 volts	11 ma. maximum

NOTE: (*) — For 0 volts at DC input and negative trip points — output will be −10 ±2 volts
For 0 volts at DC input and positive trip points — output will be at −0.1 ±0.1 volts



KG-100 M KG-1000H BLOCK DIAGRAM



4AT-H BLOCK DIAGRAM

MISCELLANEOUS

8NI-D
EIGHT NEON INDICATORS AND DRIVERS

The Model 8NI-D provides 8 independent drivers, each with a single resistor input and a neon lamp connected to each driver. This module is compatible with digital decoders, Model BTM-L and BDM-L, as well as with standard flip-flop, inverters and amplifiers. This module is generally useful in data readout and in monitoring the status of registers, counters, etc.

MODEL NO.:	8NI-D
Type:	Neon Indicators and Drivers
Input Frequency:	1 kc*
Input Levels:	
Logical "One" (Neon On)	−10 ±2 volts
Logical "Zero" (Neon Off)	−0.25 ±0.25 volts
Input Rise Time:	Not critical
Input Loading:	1.5N per input
Power: −100 volts	9.4 ma
−12 volts	Not required
+12 volts	1.3 ma

*NOTE: Typical response of neon lamp is 10 cps to 20 cps. Signals up to 1 kc may be connected to input but lamps will not respond until steady state conditions exist.

3DS-L / 3DSA-L
3 DIGIT SCANNER

The Model 3DS-L provides operation analogous to a four pole, three position switch with three command inputs to select the position. Any four bit code can be used with this unit and additional cards may be used for operation with 8, 12, etc., bit codes. The 3DSA-L is identical to the type 3DS-L except that the collector resistors are omitted for direct parallel connection of up to 9 cards with 1 type 3DS-L for a maximum capacity of 30 digits.

MODEL NO.:	3DS-L	3DSA-L
Type:	3 Digit Scanner	3 Digit Scanner
Input Frequency:	50 kc maximum	50 kc maximum
Input Levels:		
Logical "One"	−10 ±2 volts	−10 ±2 volts
Logical "Zero"	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Input Loading:		
Data Inputs	1.25A (each input)	1.25A (each input)
Command Inputs	5A (each gate)	5A (each gate)
Output Levels:		
Logical "One"	−10 ±2 volts	*
Logical "Zero"	−0.1 ±0.1 volts	*
Output Loading:	7.5A + 6N + 5C (DC Loads Only)	*
Power: −12 volts	27 ma.	2.7 ma.
+12 volts	1.0 ma.	1.0 ma.

Notes: (*) Connected in parallel with the type 3DS-L; output levels and loading will be the same as a single type 3DS-L with up to 9 type 3DSA-L units connected to the outputs in parallel.

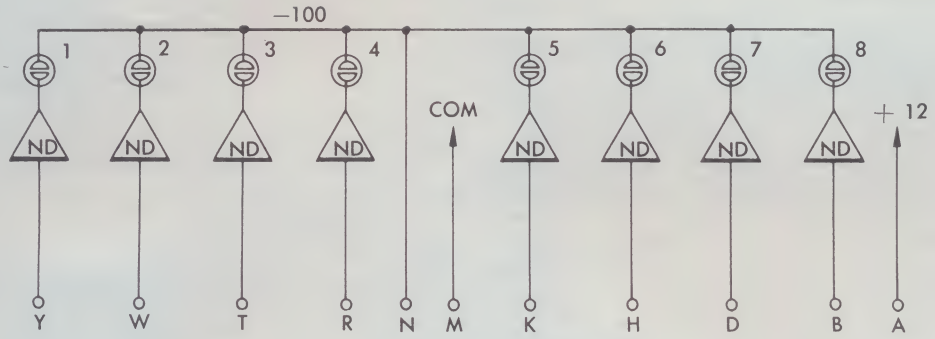
5PC-D / 5PC5-D
FIVE POWER DRIVERS

These modules provide five independent switching amplifiers. The Model 5PC-D circuits are each a two transistor amplifier' capable of switching up to −30 volts at up to 1 amp. The Model 5PC5-D is identical except that each amplifier will operate at −55 volts.

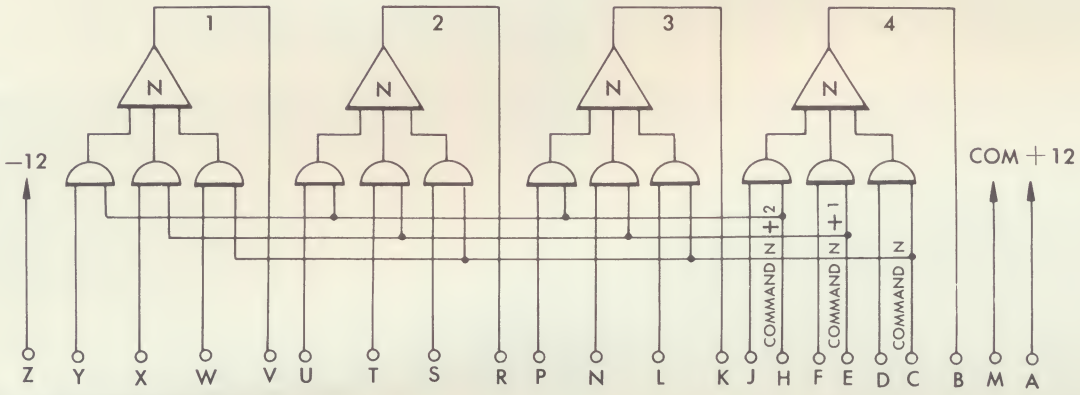
These switches connect one side of the output load to ground through the switching transistor. The other side of the load must be returned to an external negative power supply. When these units are used with relays or other inductive loads, care must be taken to properly suppress the inductive transient to protect the output transistor.

MODEL NO.:	5PC-D	5PC5-D
Type:	Five Power Drivers	Five Power Drivers
Input Frequency:	1 kc	1 kc
Input Levels:[1]		
Logical "One"	−10 ±2 volts	−10 ±2 volts
Logical "Zero"	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Input Loading:	2.75N (per input)	2.75N (per input)
Output Load:	1 amp at −30 volts (per output)	1 amp at −55 volts (per output)
Power: −12 volts	150 ma.	150 ma.
+12 volts	34 ma.	34 ma.
External Power Supply:	−30 volts max.	−55 volts max.

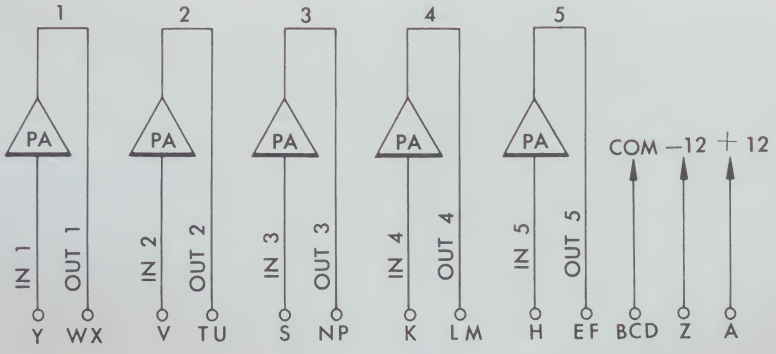
NOTE: 1) Logic "One" input energizes the output element. Logic "Zero" input de-energizes the output element.



8NI-D BLOCK DIAGRAM



3DS-L / 3DSA-L BLOCK DIAGRAM



5PC-D / 5PC5-D BLOCK DIAGRAM

MISCELLANEOUS

8PA-D
EIGHT POWER DRIVERS

The Model 8PA-D provides eight separate and independent power amplifiers suitable for driving indicator lamps or small relays. If the amplifiers are used with relays then arc suppression diodes must be connected across the relay coils. This diode should be connected between the relay power supply (−30 volts max.) and the collector of the output transistor with the cathode end (of diode-relay) at the collector.

MODEL NO.:	8PA-D
Type:	Eight Power Amplifiers
Input Frequency:	1 kc[1]
Input Levels:	
Logical "One" (output energized):	−10 ±2 volts
Logical "Zero" (output de-energized):	−0.25 ±0.25 volts
Input Loading:	1.5 N per input
Recommended Lamps:	G.E. 1813 (14 v at 100 ma.) G.E. 1829 (28 v at 70 ma.) G.E. 330 (14 v at 80 ma.) G.E. 327 (28 v at 40 ma.)
Output Load (each circuit):	120 ma. maximum at −30 v maximum
Power: −12 volts	34 ma.
+12 volts	10 ma.
External Power Supply:	−30 volts maximum

NOTE: (1) Typical response of incandescent lamps is 10 cps to 20 cps. High frequency (up to 1 kc) inputs may be connected to the inputs but lamps will not respond until steady state conditions exist.

(2) Logical "one" input energizes the output element (lamp, relay, etc.) Logical "zero" input de-energizes the output element (lamp, relay, etc.)

2RR-D/2MR-D
REED RELAYS AND DRIVERS
MERCURY RELAYS AND DRIVERS

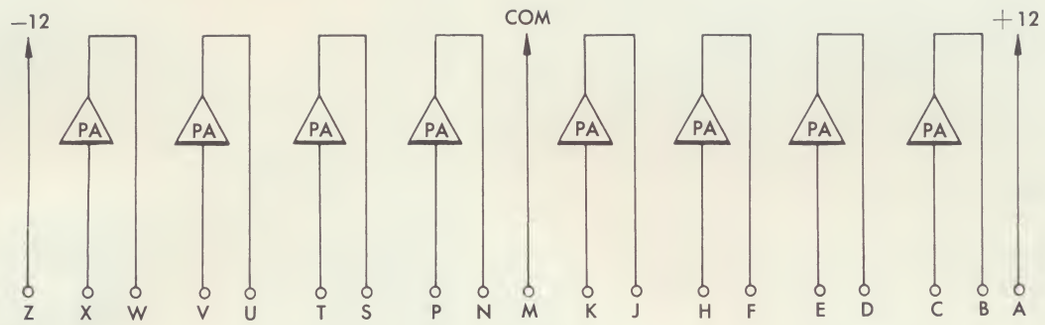
The Model 2RR-D provides two reed relays with Form C (SPDT) contacts. Separate drivers are provided, each with a three input NOR element as the first stage. The coils of the relays are protected to insure long life for the driving transistor.

The Model 2MR-D provides two Mercury wetted relays with Form D (SPDT) contacts. Separate drivers are provided, each with a three input NOR element as the first stage. The Model 2MR-D should be mounted horizontally as in Wyle standard card files.

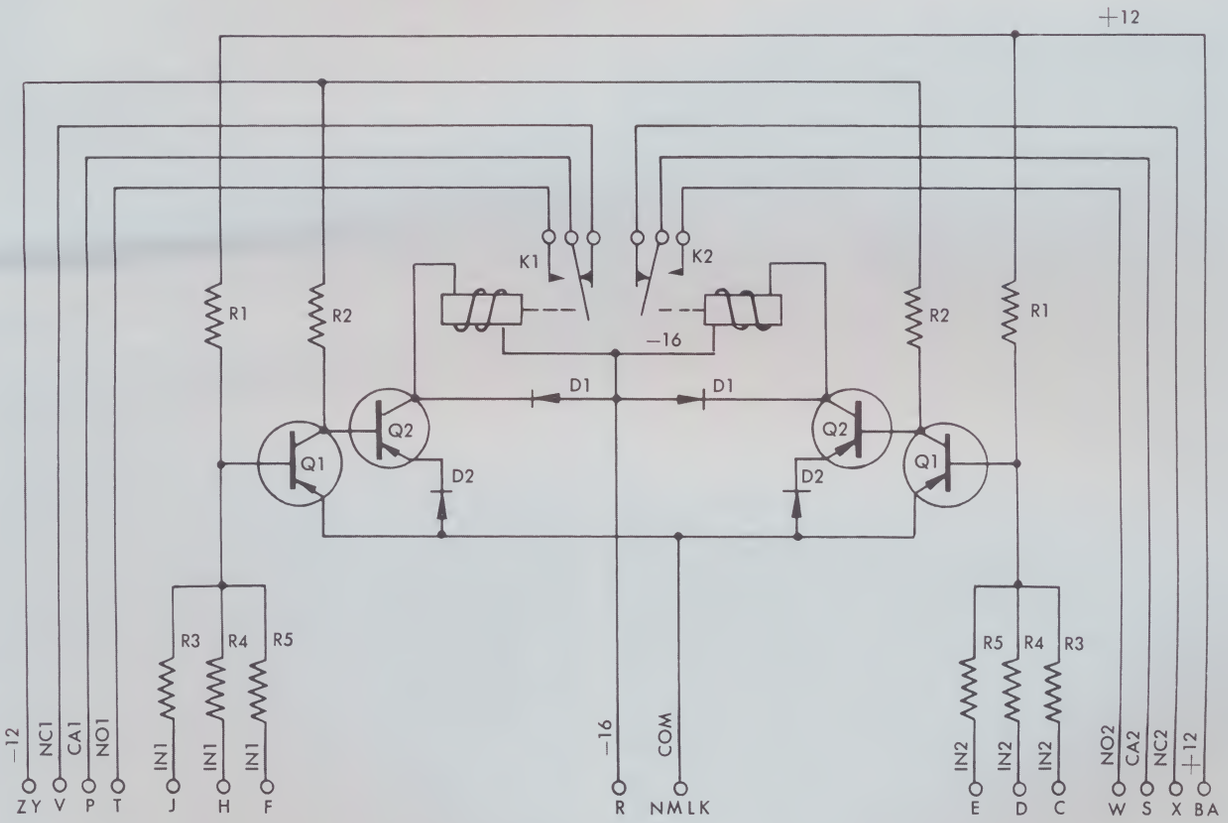
MODEL NO.	2MR-D	2RR-D
Type:	2 Mercury relays and drivers	2 Reed relays and drivers
Input Frequency:	75 cps maximum	75 cps maximum
Mounting Position:	Horizontal	Horizontal or Vertical
Input Levels:		
Relay "ON"[1]	−0.25 ±0.25 volts	−0.25 ±0.25 volts
Relay "OFF"[2]	−10 ±2 volts	−10 ±2 volts
Input Loading:	1.5 N per input	1.5 N per input
Contacts:	Form D (SPDT)	Form C (SPDT)
Contact Rating:	2 amp or 500 volts or 100 VA (protected) maximum	1 amp or 250 volts or 15 VA (protected) maximum
Power: −12 volts	8.9 ma.	8.9 ma. (both relays energized)
+12 volts	0.4 ma.	0.4 ma. (both relays de-energized)
−16 volts	67 ma.	170 ma. (both relays energized)

NOTES:
1. Relay "ON" denotes the energized state (i.e. all NOR inputs at logic "zero".)
2. Relay "OFF" denotes the de-energized state (i.e. at least one NOR input at logic "one".)
3. Time required for 2RR-D contacts to change state (typical) measured with respect to input level change.

	Close	Open
Normally Open	1.5 m sec.	1.0 m sec.
Bounce	0.5 m sec.	None
Normally Closed	2.5 m sec.	1.0 m sec.
Bounce	0.5 m sec.	None



8PA-D BLOCK DIAGRAM



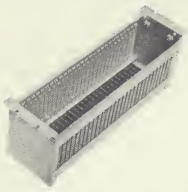
NOTES

1. POWER SUPPLY TOLERANCES: −16 V ±20%
   −12 V ± 2%
   +12 V ± 2%
2. MAXIMUM REPETITION RATE 75 CPS
3. FOR 2MR-D, CONTACTS ARE FORM D SPDT
   FOR 2RR-D, CONTACTS ARE FORM C SPDT

2RR-D / 2MR-D BLOCK DIAGRAM

ACCESSORY EQUIPMENT

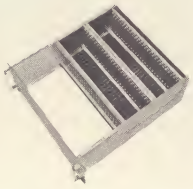
CFE-29 CARD FILE



The Model CFE-29 provides for rack mounting of up to 29 standard Wyle modules. Brackets attached to the central card file section fit a standard 19-inch rack. These brackets can be mounted at either end of the file so that either the modules or the connector wiring can be accessible from the front panel. The unit is normally supplied disassembled and can be used with a variety of connector types. Overall dimensions are 5.156" high x 19" wide x 6.875" deep.

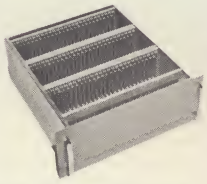
Model No. CFE-29.....Supplied without connectors
Model No. CFE-29A.....Supplied with solder lug connectors
Model No. CFE-29B.....Supplied with taper pin connectors

CH54A-8 CARD DRAWER



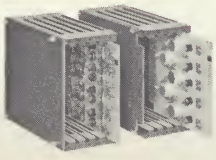
The Model CH54A-8 provides rack mounting for up to 54 standard Wyle modules. The basic drawer frame holds two files, each of which accepts up to 27 modules. The files are located at the back of the drawer to allow space behind the front panel for displays, switches, connectors, etc. The drawer mounts in a standard 19-inch rack and requires 8¾ inches of panel space. The 22-pin printed circuit connectors are included. Overall dimensions are 8¾" high x 19" wide x 18⁹⁄₁₆ inches deep. Chassis slides are optional.

CH81A-8 CARD DRAWER



The Model CH81A-8 provides rack mounting for up to 81 standard Wyle modules. The basic frame holds three files, each of which accepts up to 27 modules. The files are located at the back of the drawer. This arrangement allows space behind the panel for panel mounted switches, connectors, etc. The drawer mounts in a standard 19-inch rack and requires 8¾ inches of panel space. The 22-pin printed circuit connectors are included. Overall dimensions are 8¾" high x 19" wide x 18⁹⁄₁₆" deep. Chassis slides optional.

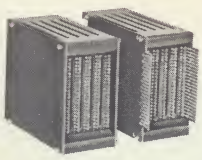
UCM UNIT CARD MODULE



The Model UCM provides a means of assembling one or more cards into a single mechanical unit. The basic UCM is a "U" shaped molded nylon frame which is both a card guide and a physical support for both the card and for a 22-pin printed circuit connector.

The UCM modules interlock for ease of stacking and provide holes which are continuous through the stacked frames so that several UCMs can be bolted into one rigid unit.

Two types of end plates are available to protect the end cards and to provide additional mechanical rigidity. The Type M metal end plates are used when rigidity and protection of the end cards are the only requirements. The Type A end plates are epoxy boards with 22-pin male printed circuit connector etched on one end. The modules in the UCMs can be wired as a self-contained sub-assembly which uses the end plates as input/output connectors. The UCMs are available with or without connectors. Only solder lug type connectors can be used with these units.

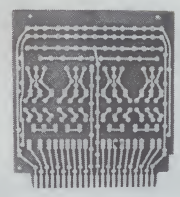


PCRT CARD RETRACTOR TOOL

The Model PCRT Printed Circuit Card Retractor Tool provides mechanical leverage and maintains alignment of the card and connector when pulling modules out of the mounting case.

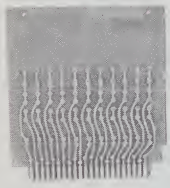
ACCESSORY MODULES

CPC COMPONENT PROTOTYPE CARD



The Model CPC is a standard size etched card for use in construction of prototypes and special modules. The pattern is arranged to accommodate up to four TO-5 transistors and a variety of diodes, resistors, capacitors, etc. This module provides a means of packaging special circuits which are mechanically compatible with Wyle modules and mounting hardware.

CTP COMPONENT MOUNTING CARD



The Model CTP is a standard size etched card which provides for mounting 11 components of 2 terminals each. The components may be of varying lengths. Separate return lines are provided for each terminal.

SP ETCHED CONNECTOR CARD

The Model SP is a standard size epoxy board, blank except for male etched 22-pin connector. It is useful in constructing special circuits requiring staked terminals or in mounting unusual components such as relays, crystals, etc.

CRL EXTENSION CONNECTOR MODULE

The Model CRL provides a 22-pin female printed circuit connector at one end, connected by the etched pattern to a male connector at the other end. When this card is plugged into a card file or drawer, a standard module can be inserted in the female connector and tested in operation while connected to the card file. Separate staked terminals are provided for clip-on connection to the power supply voltages and to ground.

SPECIAL MODULES AND ACCESSORIES

This catalog lists the basic modules and accessories required for most systems. Wyle has designed and fabricated a variety of more specialized electronic and mechanical units. For information regarding a particular application, contact Wyle Laboratories — Products Division, or the sales representative in your area.

POWER SUPPLIES

A variety of power supplies are available for use with the standard Wyle modules. These include printed circuit types which mount directly in a card file or drawer and rack mounted types for supplying power to several files or drawers.

MODEL UPS UNREGULATED POWER SUPPLY

The Model UPS provides an unregulated ±16 volts DC and 16 volts RMS at the input frequency. It is designed for card file mounting, requiring five standard card spaces. A Model 12PR Power Regulator should be used in conjunction with the UPS for powering standard modules.

Specifications:

Basic Circuit	Dual full wave bridge circuit with both plus and minus power output connections.
Input	115 volts ±10%, 60 to 400 cps
Outputs	+16 volts DC, 0.5 amps —16 volts DC, 0.5 amps 16 volts RMS, 50 ma, 60-400 cps

MODEL 12PR POWER REGULATOR

The Model 12PR operates with either the Model UPS or the Model 1152A to provide a regulated 12 volt output suitable for powering standard logic modules. The unit is a standard circuit card requiring two card spaces.

Specifications:

Inputs:	+16 volts DC ±10% —16 volts ±10% Common (ground)
Outputs:	+12 volts ±2% at 1 amp max. —12 volts ±2% at 1 amp max.

Note: ±2% regulation is for input voltage range of 15.5 volts to 17.5 volts, from no load to full load.

Negative load can be increased to 5 amps max. through use of optional external transistor.

MODEL 1520 REGULATED SUPPLY

The Model 1520 is a regulated power supply for mounting in card files or drawers, requiring 10 standard card spaces. The unit provides two separate, independent, isolated outputs and both plus and minus sense are brought out to the connector for each output.

This unit can be provided with nominal outputs of 12 volts, 15 volts, or 18 volts. The output voltage is adjustable ±12% around nominal to provide voltage adjustment over the full range of the supply. Both outputs are at the same nominal voltage but may be either plus or minus and are adjusted independently.

Specifications:

Input	115 volts ±10%, 60 to 400 cps
Output (both stages):	±12 volts, or ±15 volts, or ±18 volts 2.5 amps (Stage A); 250 ma. (Stage B)
Regulation:	±1%, no load to full load
Ripple:	10 millivolts max. (from all causes)
Voltage Adjustment	±12% of nominal voltage

MODEL 1192 RACK MOUNTED 50 VOLT SUPPLY

The Model 1192 is intended for systems use, to supply power to tape perforators, tape readers, printers, etc. It is a single ended supply designed for 19-inch rack mounting. The Model 1192 provides positive voltages, the Model 1192A provides negative voltages.

Specifications:

Basic Circuit	Full-wave bridge
Input	105 to 125 VAC, 60 to 400 cps
Output	Model 1192: +50 volts at 2 amps +2 volts at 2 amps Model 1192A: —50 volts at 2 amps —2 volts at 2 amps
Dimensions	19" W x 3½" H x 11" D

MODEL 1152A
UNREGULATED RACK MOUNTED POWER SUPPLY

The Model 1152A is designed for 19-inch rack mounting and provides unregulated +16 volts and — 16 volts. The units consists of two separate DC supplies with AC line regulation installed in a single chassis. This unit should be used in conjunction with one or more Model 12PR Power Regulators.

Specifications:

Basic Circuit	Full-wave bridge with center tap. Line regulating transformer
Input	105 to 125 VAC, single phase, 60 ±10 cps
Output	Stage A: +16 volts at 2 amps —16 volts at 2 amps Stage B: —16 volts at 5 amps
Regulation	Line; ±2% Load; ±8%
Dimensions:	19" W x 3½" H x 11" D

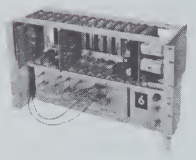
MODEL 1260 STANDBY POWER SUPPLY

The Model 1260 is a standby unit which supplies battery power in the event of line power failure. There are no transients at switch over. The unit consists of rechargeable batteries floated under trickle charge conditions across the DC output. The unit is designed for 19-inch rack mounting.

Specifications:

Basic Circuit:	Regulated DC power supply furnished with rechargeable batteries for fail safe operation.
Input	105 to 125 VAC, 50 to 60 cps
Output	+12 volts ±2% at 0.5 amps —12 volts ±2% at 0.5 amps
Fail Safe Operation	Approximately 5 amp-hours at ±11 volts
Dimensions:	19" W x 3½" H x 11" D

MODEL 1165A Card Test Display Unit



The Model 1165A Card Test Display is designed for operational testing of Wyle Laboratories standard solid-state, printed circuit modules. The unit consists of a card file, which will mount up to 10 standard printed circuit cards, and a patch panel point-to-point wired to the card file connectors. In addition to the module test function, the Model 1165A can also be used either as a teaching aid or for prototype assembly of logic modules.

The card file provides mounting for both the card under test and for a variety of signal generating and conditioning modules when these are necessary. Input signals and loads are connected to the test module by manual patching to the appropriate pin holes. Power is supplied to all the cards by a ±16 volts unregulated supply, Model UPS. This is reduced to a regulated ±12 volts by a Model 12PR Power Regulator. Both units are mounted in the card file.

Continued from page 3

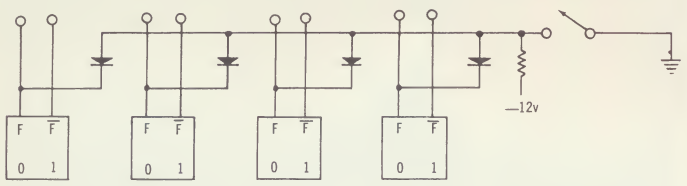
INTRODUCTORY SPECIFICATIONS

APPLICATION TECHNIQUES

The Wyle line of standard Germanium modules has been designed to be readily understood and readily applied. There are, however, certain limitations. The few following rules and techniques should be observed in system design to reduce "debugging" and rework to the minimum.

COLLECTOR PRESETTING

Collector presetting is a technique useful in resetting or presetting counters and registers when normal reset and preset inputs are not available or when faster operation is required. A diode is connected to the collector (output) of the transistor which is to be turned "ON", as shown below.



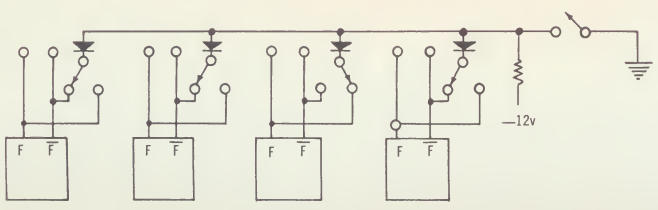
Collector Resetting To Zero State

In the case shown, the "TRUE" outputs are all grounded through the diodes when the switch is closed. This forces the outputs to

$F = -0.25 \pm 0.25$ volts
$\bar{F} = -10 \pm 2$ volts

so that the flip-flops are all reset to the "FALSE" (logical zero) state.

The same technique can be used to preset a counter to a given number as shown below.



Collector Presetting

The individual switches are set to the desired state and the selected outputs are grounded through the master switch. In the case illustrated the resulting state would be 1101, reading from left to right.

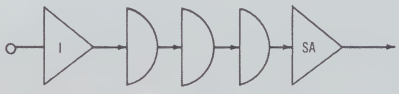
If flip-flops are reset or preset normally, a carry from one circuit might trigger another circuit unless a sufficiently long pulse is used. The collector preset/reset technique suppresses the carry signals and allows use of a shorter pulse.

DC RESTORATION

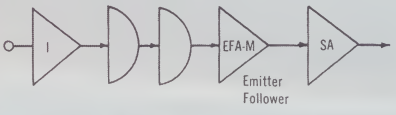
Logic Zero voltage is specified as 0 to —0.5 volts (—0.25 ±0.25) over the entire operating temperature range. This implies a maximum series chain of one diode and one "turned on" transistor. As an example, an Inverter and an AND gate.

Temp.	VCF + Vf = Total Drop
0°C	0.11 + 0.36 = 0.47 V
25°C	0.15 + 0.30 = 0.45 V
50°C	0.24 + 0.26 = 0.50 V

If the DC level is restored at the end of a chain, however, the total drop can be allowed to increase; logic zero can go to —1.25 volts and logic one to —7 volts. The Models 8SA-M and 8SA-H are designed specifically for this restoration function. With the use of the 8SA- modules, the following chains can be used.



Cascade — 3 AND Gates and Inverter

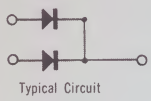


Cascade — 2 AND Gates, Inverter, Emitter Follower

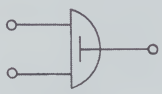
When restoration is not used an AND gate should be driven only by a turned-on transistor.

GATE EXPANDERS

Several standard AND gates, the Models A26-, A35-, A44-, provide gating adequate for most requirements. When an AND gate of more than four terms is required, the 6GE-H Gate Expander module can be employed. This module provides six circuits of the type shown below:

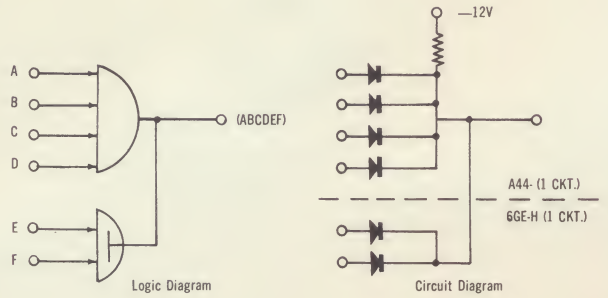


Typical Circuit
(6 per module)



Logic Diagram

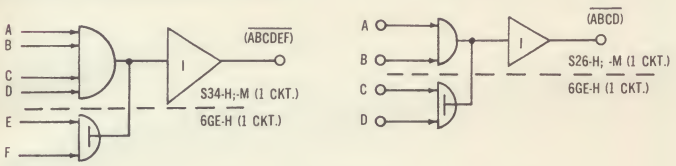
This is essentially a two term AND gate without the resistor. This circuit can be used to expand a four term AND gate to a six term gate as shown below:



The circuits on the 6GE-H module can also be used with external resistors to form conventional AND gates.

In either type of application, the number of input terms for any one gate should not exceed eight.

The 6GE-H can also be used to expand the input stage of NAND gates. Since a NAND is nothing more than an AND gate followed by an Inverting Amplifier, the 6GE-H can also be used to expand the input stage of a NAND gate. This requires that the point of connection which is both the AND gate output and the Inverter input (Node) be available. The node is available on the module connector for one circuit of the S26-M and S26-H, and for 3 of the 4 circuits on the S34-M and S34-H.



Logic Diagram: 6GE-H used to expand NAND gate

CURRENT DRAIN

The current which each module requires is listed for the +12 volt and the —12 volt supply. The values given are for the logically worst case; that combination of input and output signal values which requires the most current. These current values are not, however, for the worst case of component or power supply tolerances. The figures given represent an average or "nominal" worst case.

POWER SUPPLY TOLERANCES

To insure trouble free operation the two power supply voltages, +12 volts and —12 volts, should each vary no more than ±2%. This is the tolerance of Wyle's standard power regulators and if these power sources are used this limitation is of no concern. When using other power sources, however, this limit of ±2% independent variation should be observed.

SPURIOUS TRIGGERING

In systems applications, a possible source of logical errors is spurious triggering. Simple precautions in wiring techniques will prevent this type of error.

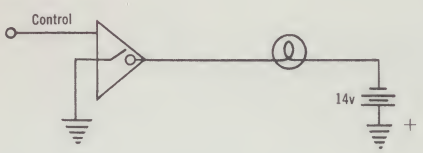
Large bundles of lead wires should be avoided since capacitive coupling between wires can introduce spurious signals onto adjacent leads. Particular care should be taken to separate incoming signals such as presetting or resetting signals, generated by relays or switches, from the lines carrying logic input or output signals to or from flip-flops.

One possible type of noise problem is triggering of flip-flops through noise introduced onto the output leads. If buffer amplifiers are used at the point where such signals leave the logic chassis, this problem can be eliminated.

POWER DRIVER MODULES

Wyle offers a variety of modules which include power drive capabilities. These range from specific power drivers to decoder matrices with power drive outputs. Rather than providing a specific voltage and current output, which would unduly restrict the types of output devices which the modules could accommodate, the Wyle modules operate as power switches to complete the circuit of load and power supply. By operating in this fashion, the circuits can be used over a wide range of voltage and currents.

As an example, consider an 8PA-D module with one of its eight circuits connected to drive a 14 volt lamp. The general circuit arrangement can be thought of as shown below.



The input to the power driver is through the control line. This is the input referred to by the specifications for "Input Loading" and "Input Voltage". When the input signal is at logical "one", the solid state switch closes completing the circuit through the load.

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